

# Nuytsia

WESTERN AUSTRALIAN HERBARIUM  
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Department of  
Parks and Wildlife



This volume of *Nuytsia* is dedicated to Elizabeth A. George (1935–2012), botanist, enthusiastic member of the Western Australian Wildflower Society, long-time volunteer at the Western Australian Herbarium, and above all expert on the taxonomy, conservation and horticulture of the genus *Verticordia*. Among many other accomplishments, Elizabeth in 2002 authored '*Verticordia: The Turner of Hearts*', the definitive work on the genus.

Cover image: *Verticordia plumosa* (Desf.) Druce by Kevin R. Thiele (Voucher: K.R. Thiele 3903).

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DEPARTMENT OF PARKS AND WILDLIFE  
WESTERN AUSTRALIA

## *Nuytsia*

*Nuytsia* is a peer-reviewed journal that publishes original papers and short communications on the systematics, taxonomy and nomenclature of Australian (particularly Western Australian) plants, algae and fungi.

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Telephone: +61 8 9219 9000  
Facsimile: +61 8 9334 0327

Postal address:  
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Science Division  
Department of Parks and Wildlife  
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## CONTENTS

<b>Papers</b>	<b>Page</b>
<i>Swainsona thompsoniana</i> (Fabaceae: Faboideae: Galegeae), a new species endemic to the Pilbara bioregion of Western Australia. R.W. Davis and P.J.H. Hurter .....	1
<i>Solanum zoeae</i> (Solanaceae), a new species of bush tomato from the North Kimberley, Western Australia. R.L. Barrett.....	5
Four new species of <i>Astrolooma</i> (Ericaceae: Styphelioideae: Stypheliae) from Western Australia. M. Hislop, A.J.G. Wilson and C. Puente-Lelièvre .....	23
A revision of the Australian species of <i>Eclipta</i> (Asteraceae: Ecliptinae), with discussion of extra-Australian taxa. A.E. Orchard and E.W. Cross.....	43
Allan Cunningham's Timor collections. A.E. Orchard and T.A. Orchard.....	63
<i>Cochlospermum macnamarae</i> (Bixaceae), a rare, new endemic from the Pilbara bioregion of Western Australia. M. Hislop, K.R. Thiele and D. Brassington .....	89
Two Western Australian species of <i>Ozothamnus</i> transferred to <i>Pithocarpa</i> (Asteraceae: Gnaphalieae). R.L. Barrett, A.N. Schmidt-Lebuhn and K.R. Thiele .....	103
<i>Pleurocarpaea gracilis</i> (Asteraceae: Vernonieae), a new species from the Pilbara region of Western Australia. N.S. Lander and P.J.H. Hurter .....	109
<i>Pilbara</i> , a new genus of Asteraceae (tribe Astereae) from Western Australia. N.S. Lander .....	117
A taxonomic review of the <i>Solanum sturtianum</i> subgroup of subgenus <i>Leptostemonum</i> (Solanaceae). A.R. Bean .....	129
A re-assessment of the varieties recognised in <i>Verticordia plumosa</i> (Myrtaceae: Chamelaucieae). A.M. Harris and B.L. Rye .....	163
Two new species of <i>Lepidosperma</i> (Cyperaceae) occurring in the Perth area of Western Australia. R.L. Barrett and K.L. Wilson .....	173
A revision of the south-western Australian genus <i>Astartea</i> (Myrtaceae: Chamelaucieae). B.L. Rye .....	189
Two new species of <i>Westringia</i> sect. <i>Cephalowestringia</i> (Lamiaceae: Westringieae) from the south-west of Western Australia. R.W. Davis and P. Jobson.....	271
<i>Acacia gibsonii</i> , a distinctive, rare new species of <i>Acacia</i> sect. <i>Juliflorae</i> (Fabaceae:Mimosoideae) from south-west Western Australia. B.R. Maslin .....	277

A revision of the species of <i>Hypocalymma</i> (Myrtaceae:Chamelaucieae) with smooth or colliculate seeds. B.L. Rye, P.G. Wilson and G.J. Keighery .....	283
A taxonomic update of <i>Conostephium</i> (Ericaceae: Styphelioideae: Stypheliae). M. Hislop .....	313
The <i>Wollastonia/Melanthera/Wedelia</i> generic complex (Asteraceae: Ecliptinae), with particular reference to Australia and Malesia. A.E. Orchard .....	337
Distinguishing characters of <i>Hemigenia rigidula</i> , a conservation significant species confused with <i>H. pritzelii</i> (Lamiaceae: Westringieae). G.R. Guerin .....	467
<i>Hibbertia sericosepala</i> (Dilleniaceae), a new species from Western Australia. K.R. Thiele .....	479
An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae. 1. <i>Calytrix</i> . B.L. Rye .....	483
Typification and application of names in <i>Drosera</i> section <i>Arachnopus</i> (Droseraceae). R.L. Barrett and A. Lowrie .....	527
A baker's dozen of new wattles highlights significant <i>Acacia</i> (Fabaceae: Mimosoideae) diversity and endemism in the north-west Kimberley region of Western Australia. B.R. Maslin, M.D. Barrett and R.L. Barrett .....	543
<i>Amanita lesueurii</i> and <i>A. wadjukiorum</i> (Basidiomycota), two new species from Western Australia, and an expanded description of <i>A. fibrillipes</i> . E.M. Davison, L.E. McGurk, N.L. Bouger, K. Syme and E.L.J. Watkin .....	589
<b>Short Communications</b>	
'There are greater things in life than cricket': <i>Tetratheca aphylla</i> (Elaeocarpaceae), James Drummond and the exploration of the Helena and Aurora Range. N. Gibson and R. Butcher .....	95
Correction to the type locality of <i>Grevillea tenuiloba</i> (Proteaceae). M. Lewington .....	101
Review of infraspecific taxa in <i>Ptilotus gardneri</i> and <i>P. lophotrichus</i> and lectotypification of <i>P. conicus</i> (Amaranthaceae). T.R. Lally .....	125
Removal of <i>Gunniopsis</i> sp. Fortescue (M.E. Trudgen 11019) from Western Australia's plant census. J.A. Wege .....	171
<i>Hibbertia</i> sp. Mt Lesueur (M. Hislop 174) cannot be maintained as distinct from <i>H. crassifolia</i> . K.R. Thiele .....	475

Clarification of the locality of William Blackall's collection of the Threatened species <i>Grevillea phanerophlebia</i> (Proteaceae). M. Lewington .....	477
Updates to Western Australia's vascular plant census for 2012. L.J. Biggs and C.M. Parker.....	503
Corrigendum to: A revision of the south-western Australian genus <i>Astartea</i> (Myrtaceae: Chamelaucieae). B.L. Rye .....	607
Corrigendum to: A revision of the species of <i>Hypocalymma</i> (Myrtaceae: Chamelaucieae) with smooth or colliculate seeds. B.L. Rye.....	609

#### **Other content**

Referees for Volume 23.....	611
Conservation Codes for Western Australian Flora and Fauna .....	613



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***Swainsona thompsoniana* (Fabaceae: Faboideae: Galegeae), a new species endemic to the Pilbara bioregion of Western Australia****Robert W. Davis<sup>1</sup> and P. Johan H. Hurter<sup>2</sup>**

<sup>1</sup>Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

<sup>2</sup>GHD, 239 Adelaide Terrace, Perth, Western Australia 6004

<sup>1</sup>Corresponding author, email: robert.davis@dec.wa.gov.au

**Abstract**

Davis, R.W. & Hurter, P.J.H. *Swainsona thompsoniana* (Fabaceae: Faboideae: Galegeae), a new species endemic to the Pilbara bioregion of Western Australia. *Nuytsia* 23: 1–4 (2013). *Swainsona thompsoniana* R.W.Davis & P.J.H.Hurter is described here as new. An amendment to an existing key for *Swainsona* Salisb. is provided to account for *S. thompsoniana*. *Swainsona thompsoniana* occurs on cracking clay soils from east of Pannawonica to Mount Florence Station and south-east to Tom Price and Wittenoom; a distribution map is included.

**Introduction**

*Swainsona* Salisb. is a relatively large genus of approximately 70 taxa endemic to Australia, 47 of which occur in Western Australia. The genus consists mostly of annual and perennial herbs which are predominately found in the drier regions of central Australia. The last revision of the genus was carried out by Joy Thompson (1993), wherein she described 16 new taxa. Although the new species described herein—*S. thompsoniana* R.W.Davis & P.J.H.Hurter—was informally named in 1996 as *Swainsona* sp. Hamersley Station (A.A. Mitchell 196), there have been no new species of *Swainsona* formally described from Western Australia since Thompson (1993). *Swainsona thompsoniana* is a prostrate annual which inhabits cracking clays in the Hamersley Range, occurring east of Pannawonica in a south-easterly band to Tom Price and Wittenoom.

**Methods**

Measurements of vegetative parts were taken from dried specimens; floral parts were measured from reconstituted material. Where possible, to maintain consistency and comparability, we have followed Thompson's (1993) taxonomic description format. The distribution map of *S. thompsoniana* is based on PERTH specimen data.

## Taxonomy

**Swainsona thompsoniana** R.W.Davis & P.J.H.Hurter, sp. nov.

*Typus*: track to Pindering Well, Hamersley Station, Western Australia [precise locality withheld for conservation reasons], 2 September 1991, M.E. Trudgen & S. Maley MET 10645 (*holo*: PERTH 06075398; *iso*: CANB, NSW).

*Swainsona* sp. Hamersley Station (A.A. Mitchell 196), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 9 March 2012].

A prostrate, annual *herb*, to 10 cm high. *Stems* terete, slightly ribbed, with a mixture of sparse, turgid and strigose, basifixied hairs. *Leaves* 1.5–2 cm long, with 3–6 pairs of leaflets; leaflets narrowly obovate to ovate, 4–13 mm long, 2–4 mm wide, glabrous or with a sparse indumentum of turgid to strigose, basifixied hairs on both surfaces, the margins with sparse, strigose hairs, the apex rounded to apiculate. *Stipules* attenuate, 2–2.2 mm long, glabrous except for sparse, strigose hairs on margins. *Racemes* (1.5)–2–6 cm long, 1–3 flowered. *Peduncle* slender, 0.2–0.25(–0.3) mm wide, with sparse, strigose hairs; pulvinus absent. *Bracts* narrowly lanceolate, 2–2.3 mm long. *Flowers* mauve with cream to yellow centres, 5–7 mm long, on slender, sparsely strigose pedicels 2–4 mm long. *Hypanthium* long and tapering, 0.5–0.7 mm long; bracteoles attenuate, 1–1.2 mm long, at the base of the hypanthium. *Calyx* with the tube 1–1.4 mm long, expanded towards the top, often glabrous or with occasional strigose hairs, the lobes narrowly triangular, 2–2.5 mm long, with strigose hairs. *Standard* nearly as broad as long, mauve with a cream to yellow centre, 5.7–6.6 mm long, 5–5.5 mm wide, the apex slightly emarginate, the claw short, 0.3–0.5 mm long. *Wing* mauve, 4.8–5.2 mm long, 1.5–1.7 mm wide, oblong and narrowly obtuse, the claw short and somewhat curved, the auricle deep and long. *Keel* dark mauve to purple fading to cream at base, 6.5–7 mm long, 2.4–2.6 mm deep, apex somewhat narrowly obtuse, claw 2.4–2.6 mm long, auricle truncate to absent. *Ovary* elliptic to narrowly lanceolate, 3.5–4.5 mm long, with dense, appressed hairs on upper edge; style shortly tapering. *Stipe* terete, slender, 2.3–2.7 mm long, with sparse, strigose hairs. *Style* slightly to moderately curved, 2–2.5 mm long, only slightly laterally compressed, shortly tapering towards apex, with hairs along adaxial edge. *Fruit* 38–60 mm long, 5–6 mm wide, elliptic, slightly curved, inflated on either side of a variably intruded suture so that it is sometimes dorsiventrally compressed, with short, strigose to turgid, basifixied, appressed hairs, the texture thin and softly leathery; surface with fine, reticulate veins. *Seeds* c. 20–30, brown, glossy, 2.2–2.7 mm long.

*Specimens examined*. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 29 July 2009, P. Hoffman & R. Butler RB 047 (PERTH); 24 Aug. 1995, S. van Leeuwen 2052 (PERTH); 11 Apr. 1997, M.E. Trudgen MET 15137 (PERTH); 28 Apr. 1997, M.E. Trudgen MET 15472 (PERTH); 3 Apr. 2009, M.S. Trudgen BES MST 355 (PERTH); 28 Aug.–7 Sep. 1998, M. Maier s.n. (PERTH 05986540); 30 Mar. 1994, A.A. Mitchell PRP 196 (NSW, PERTH); 6 Sep. 1995, A.A. Mitchell PRP 706 (NSW, PERTH); 13 Sep. 1995, A.A. Mitchell PRP 798 (NSW, PERTH); 4 Sep. 1996, A.A. Mitchell PRP 1477 (NSW, PERTH).

*Distribution and habitat*. *Swainsona thompsoniana* occurs in the Hamersley Range, from east of Pannawonica to Mount Florence Station, then south-east towards Tom Price and Wittenoom (Figure 1). It inhabits open flood plains on heavy clay soils and is often associated with *Eremophila maculata*, *Astrebla pectinata*, *Aristida latifolia*, *Eragrostis xerophila* and *Streptoglossa bubakii*.

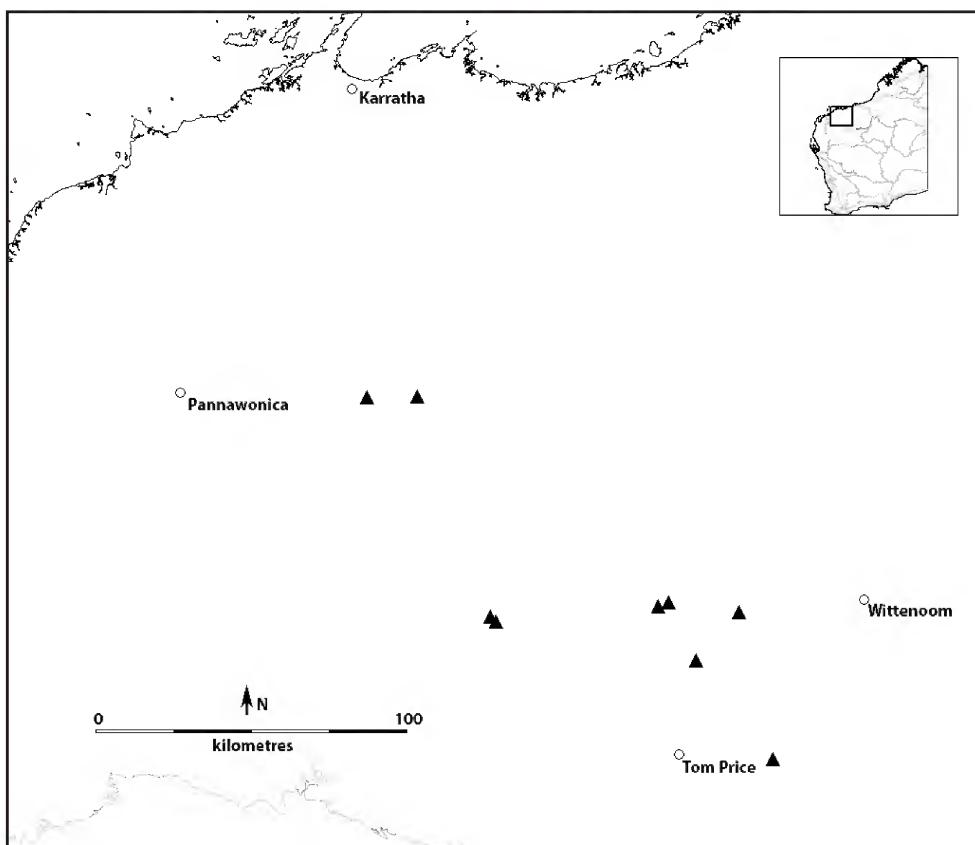


Figure 1. Distribution of *Swainsona thompsoniana* (▲), Western Australia.

**Conservation status.** There are relatively few collections of *S. thompsoniana* in the Western Australian Herbarium (PERTH); however, it occurs over an area of c. 200 km<sup>2</sup> and is reserved in two National Parks (Millstream-Chichester and Karijini). Consequently, this species is currently listed by Smith (2012) as Priority Three under the Department of Environment and Conservation's Conservation Codes for Western Australian Flora, as *Swainsona* sp. Hamersley Station (A.A. Mitchell 196).

**Phenology.** Little is known about this species' phenology. Most collections of *S. thompsoniana* at PERTH were found to be flowering and fruiting from August to September, with one specimen flowering and fruiting in March. Almost all the specimens examined have a mixture of mature fruit, flowers and buds.

**Etymology.** The species is named after Joy Thompson in recognition of her contribution to the taxonomy of *Swainsona*.

**Affinities.** In many respects *S. thompsoniana* is similar to *S. campylantha* F.Muell., especially with their diminutive, prostrate habit and long, chartaceous fruit. However, *S. campylantha* can be quickly separated because of its long and prominent, obtuse appendages on the wing petals. While not normally taxonomically useful in *Swainsona*, the size and shape of the leaflets are in this case effective discriminating characters; *S. campylantha* has much longer leaflets (25–70 mm long), which are elliptic to lanceolate, in contrast to *S. thompsoniana*, which has leaflets 5–10 mm long and obovate to ovate in

shape. The two species can also be separated on their geographic distribution. Where *S. campylantha* occurs in the Dampierland bioregion of the Kimberleys, the Tanami Desert bioregion and along the north-eastern border of the Pilbara and the Great Sandy Desert bioregions, *S. thompsoniana* is restricted to the central south-western parts of the Pilbara bioregion.

#### **Amendment to the key to species of *Swainsona* (Thompson 1993: 441)**

- 39:** Stem-hairs sparse or absent or if rather dense then appressed
- 41:** Plant perennial and shrublike with the leaflets often reduced or absent; flowers yellow ..... ***S. laxa***
- 41:** Plant annual; leaflets not reduced; flowers purple to dark red
- 42:** Stems with broad flat or turgid hairs ..... ***S. complanata***
- 42:** Stems glabrous or with fine hairs, or with a mixture of fine and turgid hairs
- 42a:** Stems erect, glabrous or with fine hairs; flowers dark red,  
c. 10 mm long ..... ***S. stenodonta***
- 42a:** Stems prostrate, glabrous or with a mixture of fine and turgid hairs;  
flowers mauve with yellow centres, 5–7 mm long ..... ***S. thompsoniana***

#### **Acknowledgements**

We would like to thank Kevin Thiele, Ryonen Butcher and the referee Peter Jobson for their suggestions towards the improvement of this manuscript, and Steve Dillon for his assistance with the distribution map.

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<http://florabase.dec.wa.gov.au/> [accessed 9 March 2012].

***Solanum zoeae* (Solanaceae), a new species of bush tomato from the North Kimberley, Western Australia****Russell L. Barrett**

Botanic Gardens and Parks Authority, Kings Park and Botanic Garden,  
West Perth, Western Australia 6005  
School of Plant Biology, Faculty of Natural and Agricultural Sciences, The University of Western Australia,  
Crawley, Western Australia 6009  
Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983  
Email: russell.barrett@bgpa.wa.gov.au

**Abstract**

Barrett, R.L. *Solanum zoeae* (Solanaceae), a new species of bush tomato from the North Kimberley, Western Australia. *Nuytsia* 23: 5–21 (2013). Recent surveys in the North Kimberley have brought numerous new species to light. Studies have revealed considerable taxonomic complexity in the genus *Solanum* L. in the Kimberley region that requires the recognition of a number of new taxa. *Solanum zoeae* R.L. Barrett is described here following collection of the first fertile material on a remote sandstone outcrop on Doongan Station. Notes are provided on all phrase-named *Solanum* taxa currently recognised in the Kimberley region and a revised key to *Solanum* species in the Kimberley region is provided.

**Introduction**

The genus *Solanum* L. is a large, cosmopolitan genus of over 1,250 species (Mabberley 2008). Numerous new species have been recognised in Australia since the treatments of Symon (1981) and Purdie *et al.* (1982), particularly in Queensland and central Australia (e.g. Bean 2001, 2004, 2011, 2012; Symon 2001; Brennan *et al.* 2006; Bean & Albrecht 2008). Six new species have been recognised by phrase names in Western Australia (four from the Kimberley region and two from the Pilbara region), with additional species groups from the Kimberley region requiring further study. One Pilbara taxon has recently been named (Davis & Hurter 2012). When naturalised taxa are included there are about 185 species currently recognised in Australia (Barker 2010). Recent phylogenetic studies of *Solanum* in northern Australia by Martine *et al.* (2009) have also recommended the recognition of additional taxa in this region.

*Solanum zoeae* R.L. Barrett was first collected in 2008 by the author while on a field trip for a conservation organisation. The author was flown in by helicopter to join the conservation group at a remote sandstone escarpment. A brief opportunity was available to examine the flora in the area and the first known collection of this taxon was made. At the time, little fertile material could be located with only one plant holding one, old flower. The leaf shape and very fine indumentum suggested that it might represent a distinct taxon related to *S. leopoldense* Symon. Heavy wet season rains associated

with Cyclone Lua in March 2012 extended the flowering season of many species in the region and a return visit to the original location in search of fertile material at the beginning of June 2012 was successful in locating numerous fruiting plants and a small number of flowering plants. Comparison of this material to *S. leopoldense* and *S. petraeum* Symon has confirmed that it differs from both species in a number of characters. This material is used to formally describe the new species.

## Methods

This description is based on measurements from fresh specimens and pressed material now at PERTH. Terminology and the layout of the description follows Symon (1981). Illustrations are based on photographs of live plants and from herbarium material. Seeds and indumentum characters were imaged using a Jeol JCM 5000 NeoScope bench top scanning electron microscope (SEM) at Kings Park and Botanic Garden.

## Taxonomy

### ***Solanum zoeae* R.L.Barrett, sp. nov.**

*Type:* Doongan Station, Western Australia, 6 June 2012, R.L. Barrett RLB 7700 (bisexual plant) (*holo*: PERTH 08386048; *iso*: AD, BRI, CANB, DNA, K, MEL).

Intricate, many-branched, erect to spreading, dioecious *shrub* 0.7–1.5(–1.9) m high, 0.5–1 m wide; stems to 3 cm diam. at base; bark with pale ‘warts’ (lenticels or tubercles at base of spines); young stems greenish, finely stellate-hairy, spiny; prickles 2–7 mm long, abundant (on stems up to 1 cm diam., upper and lower leaf surfaces, peduncles, pedicels and calyx), straight or slightly recurved, slender, pale coloured; leaves with minute, stellate hairs (subsessile porrect-stellate, central ray shortly peaked or absent), with minute, simple, stalked glandular hairs also present on margins and veins, usually only on young growth, general colour dark green. *Leaves* dark green, slightly discolourous (paler below), very finely stellate-hairy and with stalked glandular hairs on the margins and veins of young growth, (2.5–)4.9–8.9(–15.5) × 1.5–3.2(–5.0) cm, lanceolate, with (5–)7–14(–19) triangular lobes ± evenly spaced along margin; sinuses of lobes rounded to sub-acute, cut 1/2–3/4 of the way to midrib; lobe and leaf apex acute or acuminate; base cuneate, equal or oblique; petiole to 6.5 mm long. *Inflorescences* consisting of solitary female flowers and cymes of male flowers on separate plants. *Male flowers* not seen (one immature cyme seen). *Female flower*: pedicel 6–13 mm long; *calyx* tube 5–6 mm long; lobes 5–10 mm long, long-triangular including the linear apex with prominent midvein, all parts extremely prickly. *Corolla* 1.8–2.8 cm diam., purple to lavender, broadly stellate-rotate, sinuses cut to about 1/3–3/5 of petal length, the apicies sub-acute to sub-emarginate, densely minutely pubescent along the mid-portion; acumen 0.6–1.2 mm, distinct. *Filaments* 3.3 mm long, glabrous; anthers dark yellow, 4.8 mm long, tapering, closely erect. *Ovary* glabrous; style 11.7 mm long; stigma entire, projecting 2.8 mm beyond anther tips, erect or recurved. *Berry* 0.9–2.0 cm diam., depressed-globular, green when mature, finally pale brown, usually drying on bush to hard bony texture, wholly enclosed (apex visible from below) in prickly, accrescent, truncate calyx tube which has prickly, linear, lobe tips 0.8–1.5 cm long, the calyx eventually splitting irregularly to release entire, dry berry. *Seeds* 1.6–2.0 mm long, distinctly, minutely reticulate (reticulae 50–80 µm across), dark brown, 65–377 (4 fruits examined). (Figures 1, 2)



Figure 1. *Solanum zoeae*. A – the author with typical plant of *S. zoeae*; B – branched, woody stem base; C – broken sandstone habitat; D – sectioned fruit; E – fully open flower; F – seeds (R.L. Barrett RLB 7700). Scale bars D = 1 cm, F = 2 mm. Image A by David Taggart.



Figure 2. *Solanum zoeae*. A – flower with corolla torn to show staminal filaments; B – open flower demonstrating shape of fused corolla; C – Partially closed flower and spinescent calyx; D – young fruit enclosed in calyx with elongated calyx lobes; E – primary leaf spine; F – leaf lobing; G – near mature fruit (less enclosed by calyx than usual); H – fruiting calyx and mature dry fruit; I – woody stem with spines (A, B, D, E, G, H from R.L. Barrett RLB 7700; C, F, I from R.L. Barrett RLB 7575).

**Diagnostic characters.** Closely related to *S. leopoldense*, distinguished by the larger, erect habit and thick, woody stem bases. The leaves of *S. zoeae* are more deeply lobed with a very fine but very dense stellate indumentum. The segments (rays) of the individual stellate hairs are clearly demarcated (constricted at the base). The glandular hairs on the leaf margins and veins are stalked. The seeds are more finely reticulate (reticulae 60–110 µm across in *S. leopoldense*).

**Specimens examined.** WESTERN AUSTRALIA: [all in the vicinity of the type location] 23 May 2009, R.L. Barrett RLB 5720 (male plant) (AD, DNA, PERTH); 1 June 2012, R.L. Barrett RLB 7575 (female plant) (AD, BM, BRI, CANB, HO, MEL, NSW, PERTH (2 sheets)); 1 June 2012, R.L. Barrett RLB 7575 B (male plant) (PERTH); 2 June 2012, R.L. Barrett RLB 7601 (PERTH).

**Distribution and habitat.** Known only from the type location north of Doongan Station homestead in the north Kimberley. Grows on rough sandstone ridges in fire-excluding sites in association with *Acacia*

*deltoidea*, *A. delibrata*, *A. tumida*, *Breynia cernua*, *Buchanania oblongifolia*, *Calytrix exstipulata*, *Capparis umbonata*, *Corymbia disjuncta*, *Cymbopogon ambiguus*, *Denhamia obscura*, *Erythrophleum chlorostachys*, *Eucalyptus miniata*, *E. tetradonta*, *Gardenia megasperma*, *Hibiscus fryxellii*, *H. leptocladus*, *Hypoestes floribunda*, *Lithomyrtus retusa*, *Maytenus cunninghamii*, *Panicum trichoides*, *Planchonella arnhemica*, *Santalum lanceolatum*, *Setaria apiculata*, *Smilax australis*, *Spermacoce* sp., *Saxitilis* (R.K. Harwood 1538), *Stemodia lythrifolia*, *Stenocarpus acacioides*, *S. cunninghamii*, *Terminalia hadleyana*, *Triodia claytonii*, *T.* sp. King Edward River (K.F. Kenneally 7021) and *Triumfetta monstrosa*, or occasionally at the base of the sandstone on sand with *Heteropogon contortus* (Figure 3).

**Phenology.** Flowering and fruiting probably occurs mainly late in the wet season; finished by May in 2008. In early June 2012, about half the population was retaining fruit with only five plants bearing flowers.

**Conservation status.** To be listed as Priority One under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (M. Smith pers. comm.). This species is only known from the vicinity of the type collection over a range of about 1 km. About 200 plants have been observed in this area. The surrounding habitat in most directions is unsuitable for this species, but there is potentially suitable habitat to the north of the known population. There are no access tracks to the north, making further surveys difficult.

**Etymology.** The epithet honours Zoe Emily Davies who was one of the coordinators of the field trip on which this species was first found. This species was discovered the same day and in the same place that

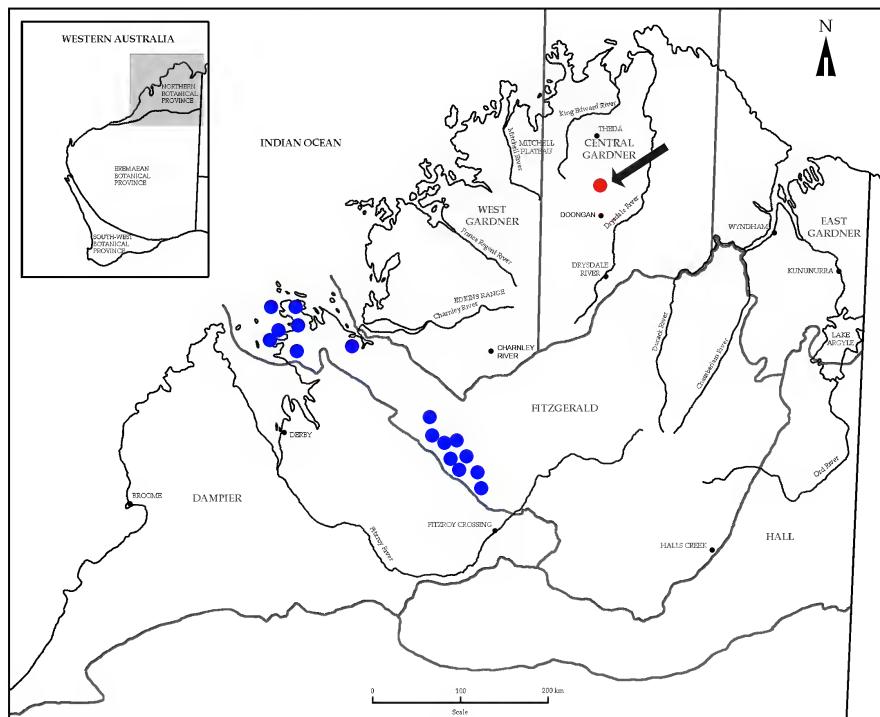


Figure 3. Distribution of *Solanum zoeae* (red dot with arrow) and *S. leopoldense* (blue dots). Map showing floristic provinces of Beard (1990).

I first met Zoe, who is now my wife. It was a chance meeting as we had both been asked to attend the field trip at short notice. When I first saw Zoe she was lying underneath a rock at the sandstone outcrop admiring some of the Indigenous rock paintings. The *Solanum* was discovered only 20 m from the spot where I met Zoe. I felt it was highly appropriate that this species be named in her honour following that wonderful chance meeting in the remote Kimberley.

*Notes.* *Solanum zoeae* belongs to subg. *Leptostemonum* sect. *Melongena* and is a member of the *S. dioicum* W.Fitzg. complex identified by Martine *et al.* (2009), a clade of entirely dioecious species.

*Solanum leopoldense* can develop thin woody stems, up to 0.6 cm thick, while *S. zoeae* is far more robust, commonly developing stems 2–3 cm thick at the base. Plants of *S. zoeae* are also more erect in habit, and much taller than *S. leopoldense*. The degree of leaf lobing is a rather variable characteristic in a number of *Solanum* species. Leaves of *S. zoeae* are consistently lobed at least halfway to the midrib and often two thirds of the way. Leaves of *S. leopoldense* are usually only lobed about a third of the way to the midrib, although one specimen from the Robinson River (*A.N. Start per R.L. Barrett RLB 2066*) has unusually large leaves which are lobed two thirds of the way to the midrib. The fine, dense indumentum on the mature leaves distinguishes most specimens of *S. zoeae* from *S. leopoldense*; however, juvenile leaves on *S. leopoldense* have a dense indumentum similar to *S. zoeae*. When imaged with an SEM, the stellate hairs differ in form; the ‘arms’ (rays) of the stellate hairs on *S. zoeae* (Figure 4A, B) consistently

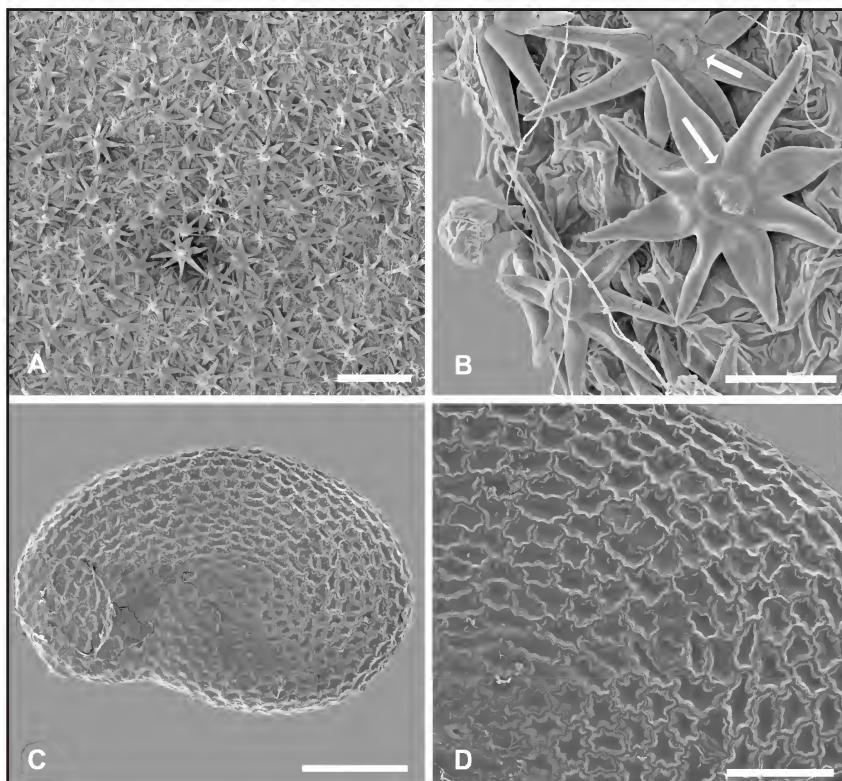


Figure 4. *Solanum zoeae*. Scanning electron micrographs. A – leaf indumentum; B – leaf margin with stalked glandular hair (centre left) and stellate hairs (lacking grooves between ‘arms’ as indicated by arrows); C – seed; D – seed reticulation (*R.L. Barrett RLB 7700*). Scale bars: A = 200 µm; B = 50 µm; C = 500 µm; D = 200 µm.

having distinct constriction grooves between the ‘arms’ and the centre (smooth, not constricted in *S. leopoldense*; Figure 5A, B). This character can be difficult to see under a light microscope but was very consistent when viewed with an SEM. The glandular hairs on the leaf margins (and occasionally on the veins) are stalked on *S. zoeae* (Figure 4B) and sessile on *S. leopoldense* (Figure 5B). The glandular hairs can often only be found on young leaves in both species. Seed reticulation of *S. zoeae* (Figure 4C, D) is finer and generally less rounded than in *S. leopoldense* (Figure 5C, D). There is a disjunction of 240 km in distribution between *S. leopoldense* and *S. zoeae*.

*Solanum zoeae* keys to Group VII of Symon (1981). It keys to couplet 31 where the deeply lobed leaves then leads to couplet 32 rather than to 34 with *S. leopoldense*. This species does not sit comfortably in couplet 32 as it has many triangular lobes on the leaves. *Solanum zoeae* keys to *S. leopoldense* in Wheeler (1992). A revised key is presented below based on Purdie *et al.* (1982) and later treatments.

Whether or not this species can be considered edible is unknown. It does not belong to the clade of true bush tomatoes identified by Martine *et al.* (2006).

Field observations showed that about 20% of fallen fruit had been predated by the larvae of an unidentified insect.

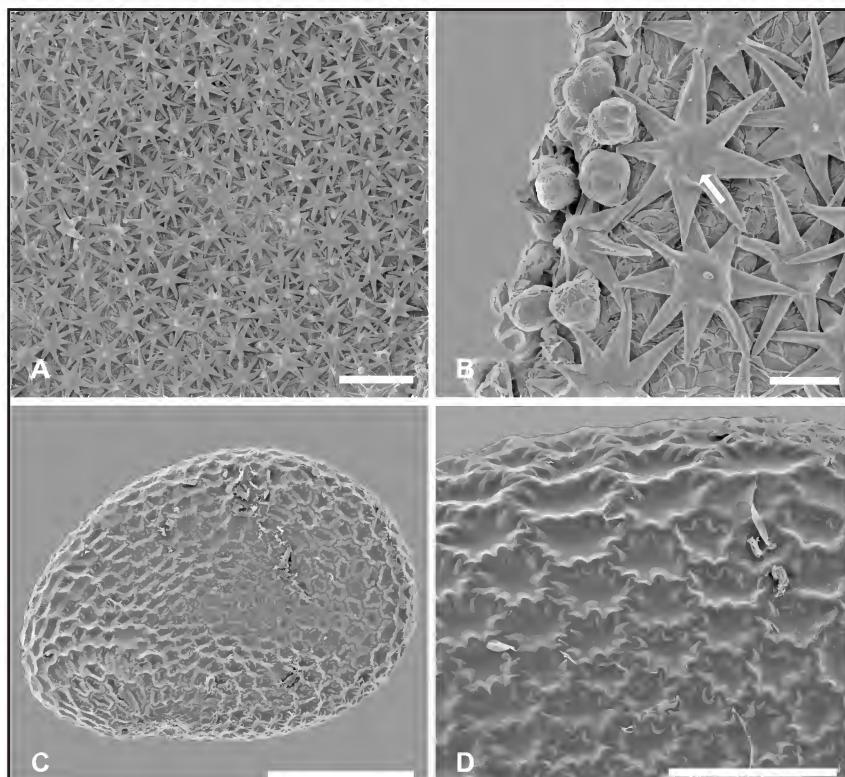


Figure 5. *Solanum leopoldense*. Scanning electron micrographs. A—leaf indumentum; B—leaf margin with sessile glandular hair (centre left) and stellate hairs (arrow indicates grooves between ‘arms’); C—seed; D—seed reticulation (D.E.Symon 10147). Scale bars: A = 200 µm; B = 50 µm; C = 500 µm; D = 200 µm.

### **Notes on phrase-named *Solanum* taxa in the Kimberley**

A number of *Solanum* taxa have been listed on Western Australia's plant census in recent years (Western Australian Herbarium 1998–) under phrase names and these are discussed below. Currently, the amount of material available is insufficient to formally describe these taxa. Notes and brief descriptions are provided here to aid their identification and encourage further collections so that they can be formally described. Additional taxa should undoubtedly be recognised in the region, but are currently included in species complexes. In particular, the current concept of *S. dioicum* is particularly morphologically variable. The Kimberley collections referred to *S. carduiforme* F.Muell. by Wheeler (1992) probably represent an undescribed species and are keyed out below as *S. aff. carduiforme*.

#### ***Solanum* sp. Bachsten Creek (R.L. Barrett & M.D. Barrett RLB 3813)**

*Subshrub*, 50–80 cm tall, dioecious. Indumentum of glandular stellate hairs, each hair stalked, with a ring of short non-glandular branches, and terminating in a very long, erect glandular branch arising from the centre of the whorl. *Leaves* entire, narrowly elliptic, ± concolourous, softly hairy with rusty grey-green, slightly ferruginous hairs; blade 15–40 mm long, 7–12 mm wide. *Female flowers* solitary, purple. *Fruit* small, c. 12 mm diam., almost entirely enclosed in expanded calyx tube that is covered in dense spines.

*Specimen examined.* WESTERNAUSTRALIA: ridgeline between Gwens Gorge south arm and Bachsten Falls (south) on E side of falls, NE of Bachsten Creek Bush Camp, southern boundary of Prince Regent Nature Reserve, 24 Jan. 2007, R.L. Barrett & M.D. Barrett RLB 3813 (PERTH 08130310).

*Conservation status.* Recently listed as Priority Two under the DEC Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–).

*Notes.* This taxon is only known from a single collection. Within the *S. dioicum* group, this species differs from all described species by the unique, elongated, gland-tipped stellate hairs. It is further distinguished from all except *S. dioicum* s. lat. and *S. vansittartense* C.A.Gardner by the entire, ± concolourous leaves. It differs from *S. dioicum* and *S. vansittartense* by the smaller fruits.

#### ***Solanum* sp. Boomerang Bay (K.F. Kenneally 10021)**

*Plant* prostrate, to 15 cm tall, dioecious. *Leaves* entire, ± linear, involute, lacking spines, covered in fine, golden, stellate hairs; blade 10–20 mm long, 2–3 mm wide. There are no flowers on the single known collection, a female plant. *Fruit* small, solitary, c. 5 mm diam., completely enclosed in the calyx at maturity; calyx densely covered in long spines; sepals extending beyond the fruit, being about half the length of the calyx.

*Specimen examined.* WESTERNAUSTRALIA: Boomerang Bay on W side of Bigge Island, Bonaparte Archipelago, W. Kimberley coast, 28 May 1987, K.F. Kenneally 10021 (AD n.v., PERTH 037000593).

*Conservation status.* Listed as Priority One under the DEC Conservation Codes for Western Australian Flora (Smith 2012).

*Notes.* This taxon is only known from a single collection. It is distinctive for its prostrate habit, fine, simple leaves and small fruit. It is probably most closely allied to *S. petraeum*, but may also have affinity with the prostrate species *S. cataphractum* Benth. Keyed out below based on bisexual plants only.

***Solanum* sp. **Longini** (C.T. Martine 807 et al.)**

*Plant* erect, 50–70 cm tall, stems with spines. *Leaves* entire, densely covered in large, thickly matted, greenish white, stellate hairs, lacking spines; 20–60 mm long, 15–30 mm wide, asymmetric at base, the surface hidden by hairs.

*Specimen examined.* WESTERN AUSTRALIA: Kalumburu area: Longini Landing, just E of road between Kalumburu and Longini Landing, 1 June 2004, C.T. Martine, B. Barker & J. Karadada CTM 807 (CONN n.v., PERTH).

*Conservation status.* Listed as Priority One under DEC Conservation Codes for Western Australian Flora (Smith 2012).

*Notes.* Allied to *S. dioicum*. No fertile material of *S.* sp. *Longini* is known but the indumentum is unique and the taxon has been identified as a unique lineage based on ITS sequence data by Martine *et al.* (2009). This species is a member of the dioecious clade, so is most likely dioecious. All related species have the calyx surrounding the berry. A visit to the original location by M. and R. Barrett located only a single plant. An additional population of 100+ plants was found further south at the base of a rough sandstone hill. This species is probably fire sensitive.

***Solanum* sp. **Prince Regent River** (T. Handasyde CH 1925)**

*Plant* erect to spreading, 20–80 cm tall, dioecious. *Leaves* lobed about 1/2–2/3 of the way to the midrib, distinctly discolourous, covered in thick, matted, pale stellate hairs, with numerous spines; blade 30–80 mm long, 10–20 mm wide. *Male flowers* in a short cyme, small, only c. 8 mm diam., pale blue. *Female flowers* solitary, larger, to c. 15 mm diam. *Fruit* c. 10–20 mm diam., completely enclosed in the calyx at maturity; densely covered in long spines; sepals persistent, extending beyond the fruit, almost as long as the calyx.

*Specimens examined.* WESTERN AUSTRALIA: 10 km NE of Prince Regent River mouth, 27 May 1993, L.A. Craven, J. McD. Stewart & C.L. Brubaker 9215 (CANB n.v., PERTH); summit of Mt Trafalgar, Prince Regent Nature Reserve, 20 Aug. 1974, A.S. George 12809 (PERTH); tributary to Prince Regent River, above Rainforest Patch 28/3, trapline 3, 24 May 2003, T. Handasyde TH 1925 (AD n.v., PERTH); c. W5 Prince Regent River Reserve, 29 Aug. 1974, K.F. Kenneally 2175 (PERTH); Kings Cascade, 85.2 km from Kuri Bay settlement on a bearing of 97 degrees, 18 Mar. 2002, A.A. Mitchell 7102 (AD n.v., PERTH).

*Conservation status.* Listed as Priority Three under DEC Conservation Codes for Western Australian Flora (Smith 2012).

*Notes.* Probably allied to the morphologically similar *S. petraeum* which has entire mature leaves and lobed juvenile leaves. The lobed leaves are similar in appearance to *S. leopoldense* and *S. zoeae*, but the indumentum is distinctly different with the stellate hairs being much more robust.

*Variants.* Two additional collections cited below are similar in having prominently lobed and strongly discolourous leaves, but a finer indumentum. One of these collections is in fruit, with the calyx not completely enclosing the fruit, distinguishing it from the specimens cited above.

*Specimens examined.* WESTERN AUSTRALIA: large gully, 10.8 km NE of junction of Youwanjela Creek and Prince Regent River, Prince Regent Nature Reserve, 20 Jan. 2007, R.L. Barrett & M.D. Barrett RLB 3665 (PERTH); small sandstone gully above Gwens Gorge south arm, NE of Bachsten Creek Bush Camp, southern boundary of Prince Regent Nature Reserve, 24 Jan. 2007, R.L. Barrett & M.D. Barrett RLB 3805 (PERTH).

Two additional collections cited below from the Edkins Range are similar to the above form in indumentum and discolourous leaves, but differ in having smaller, entire leaves.

*Specimens examined.* WESTERN AUSTRALIA: Bachsten Creek Bush Camp, Bachsten Creek South, Mt Elizabeth – Munja Road, 21 Jan. 2007, R.L. Barrett & M.D. Barrett RLB 3693 (PERTH); small sandstone gully above Gwens Gorge south arm, NE of Bachsten Creek Bush Camp, southern boundary of Prince Regent Nature Reserve, 24 Jan. 2007, R.L. Barrett & M.D. Barrett RLB 3806 (PERTH).

### Key to *Solanum* species in the Kimberley Region

The key below has been adapted from Purdie *et al.* (1982) including information from Symon (2001), Bean & Albrecht (2008), Bean (2012), and this paper. It includes a number of taxa that were not recorded at the time of Wheeler (1992) in the *Flora of the Kimberley Region: Solanum americanum* Mill., *S. chenopodium* F.Muell., *S. chippendalei* Symon, *S. eburneum* Symon, *S. secundum* A.R.Bean, *S. ferocissimum* Lindl., *S. gilesii* Symon, *S. lasiophyllum* Poiret, (*S. lycopersicum* L. was included under the genus *Lycopersicon* Mill.), *S. oligandrum* Symon, *S. pseudocapsicum* L., *S. seaforthianum* Andrews, *S. succosum* A.R.Bean & Albr., *S. tumulicola* Symon, *S. zoeae*, *S. sp.* Bachsten Creek, *S. sp.* Boomerang Bay, *S. sp.* Longini and *S. sp.* Prince Regent River.

*Solanum* sp. Boomerang Bay and *S. sp.* Longini are still imperfectly known and may not key out properly in this key. They are only included in sections of the key where their character states are certain.

1. Stellate hairs absent; prickles absent or rare (introduced species)..... 2
- 1: Stellate hairs and/or prickles present (native species)..... 6
2. Leaves deeply pinnatisect; flowers yellow; fruit red, sub-globular..... \****S. lycopersicum***
- 2: Leaves entire or lobed, not pinnatisect; flowers mauve, purple or rarely white; fruit red, green, brown or black, globular..... 3
3. Climbing or scrambling perennials; leaves deeply 3–9-lobed; berry usually 10–12 mm diam.; seeds shaggy-haired ..... \****S. seaforthianum***
- 3: Annuals or herbaceous perennials, not climbing; leaves entire, or some with 1–5 basal lobes or leaflets; berry 5–10 mm diam.; seeds not hairy..... 4
4. Leaves usually 1–2 cm wide, hairs (if present) forked; berries bright orange-red, 1 or 2 per peduncle ..... \****S. pseudocapsicum***
- 4: Leaves 1–8 cm wide, hairs not forked; berries not bright orange-red, usually 2–10 per peduncle..... 5
5. Mature berry shiny; seeds usually more than 40 in each fruit..... \****S. americanum***
- 5: Mature berry dull; seeds usually 20–40 in each fruit ..... \****S. nigrum***
6. Hairs predominantly simple or glandular..... 7

6:	Hairs predominantly stellate.....	9
7:	Fruiting calyx largely enclosing berry.....	<i>S. oedipus</i>
7:	Fruiting calyx not enclosing berry.....	8
8:	Leaves deeply and narrowly lobed; inflorescence reduced, with one bisexual flower below several male flowers; seeds discoid.....	# <i>S. oligandrum</i>
8:	Leaves with triangular lobes; inflorescence not reduced as above; seeds flat, distinctly winged.....	<i>S. pugunculiferum</i>
9:	Indumentum of glandular stellate hairs, each hair stalked, with a ring of short non-glandular branches, and terminating in a very long, erect, glandular branch arising from the centre of the whorl .....	<i>S. sp. Bachsten Creek</i>
9:	Indumentum of non-glandular stellate hairs.....	10
10:	Prickles absent or rare .....	11
10:	Prickles present on stems, leaves, petioles and/or inflorescences .....	23
11:	Flowers all male .....	12
11:	At least the basal flower bisexual .....	16
12:	Leaves linear-lanceolate, sometimes lobed .....	<i>S. tudununggae</i>
12:	Leaves lanceolate to elliptic or ovate, not lobed .....	13
13:	Leaves green.....	<i>S. vansiarttense</i>
13:	Leaves silvery or rusty .....	14
14:	Leaves discolourous, lanceolate-elliptic, rusty, 1–2 cm wide .....	<i>S. cunninghamii</i>
14:	Leaves concolourous, ovate-elliptic, rusty, silvery or greenish white, 1–5 cm wide.....	15
15:	Indumentum silvery (type form) or rusty (W Kimberley form). ....	<i>S. dioicum</i>
15:	Indumentum greenish white .....	<i>S. sp. Longini</i>
16:	Lowest flower of inflorescence bisexual, the others male, or flowers solitary and bisexual.....	17
16:	Flowers all bisexual, rarely lower ones bisexual and upper ones male.....	19
17:	Leaves lanceolate to elliptic or ovate, not lobed .....	18
17:	Leaves linear-lanceolate, sometimes lobed .....	<i>S. tudununggae</i>
18:	Leaves 10–15 mm wide; fruit c. 20 mm diam.....	<i>S. cunninghamii</i>
18:	Leaves 2–3 mm wide; fruit c. 5 mm diam.....	<i>S. sp. Boomerang Bay</i>
19:	Leaves sparsely pubescent or glabrous on upper surface.....	# <i>S. chenopodinum</i>
19:	Leaves densely to moderately pubescent on upper surface.....	20
20:	Mature berry dry, brown or black.....	21
20:	Mature berry mucilaginous, yellow, green or orange-brown .....	22
21:	Small sub-shrub to 0.5 m; calyx with few or no prickles (S Kimberley & arid Australia) .....	<i>S. centrale</i>
21:	Erect shrub to 3 m; calyx with prominent prickles (far N Kimberley) .....	<i>S. vansiarttense</i>

22. Leaves oblong, sometimes shallowly lobed; flowering pedicel 10–15 mm long; calyx lobes linear or narrow-triangular, 2–3 mm long ..... *S. esuriale*
- 22: Leaves oblong, not lobed; flowering pedicel to 10 mm long; calyx lobes triangular, 1–1.5 mm long ..... #*S. tumulicola*
23. Flowers all male ..... 24
- 23: At least basal flower bisexual; fruits, when present, one to several on each peduncle ..... 38
24. Leaves entire ..... 25
- 24: Leaves lobed ..... 31
25. Leaves lanceolate to elliptic or ovate, 10–70 mm wide ..... 26
25. Leaves linear-lanceolate or lanceolate, 8–15 mm wide ..... 29
26. Leaves green ..... *S. vansittartense*
- 26: Leaves silvery or rusty ..... 27
27. Leaves discolourous, lanceolate-elliptic, rusty, 1–2 cm wide ..... *S. cunninghamii*
- 27: Leaves concolourous, ovate-elliptic, rusty, silvery, or greenish white, 1–5 cm wide ..... 28
28. Indumentum silvery (type form) or rusty (W Kimberley form) ..... *S. dioicum*
- 28: Indumentum greenish white ..... *S. sp. Longini*
29. Leaves silvery; corolla 30–45 mm diam., purple ..... *S. tudununggae*
- 29: Leaves grey-green; corolla 15–20 mm diam., pale lavender ..... 30
30. Male flowers 15–25 mm diam., female flowers 20–30 mm diam. ..... *S. petraeum*
- 30: Male flowers c. 8 mm diam., female flowers c. 15 mm diam. ..... *S. sp. Prince Regent River* (entire leaf form)
31. Lobes cut no more than half way to midrib ..... 32
- 31: Lobes cut almost to midrib ..... 35
32. Leaves glabrous or nearly so; glandular hairs absent; lobes narrow-linear ..... *S. cataphractum*
- 32: Leaves pubescent with minute stellate and glandular hairs; lobes triangular ..... 33
33. Leaves strongly discolourous, dull olive green ..... *S. sp. Prince Regent River* (lobed leaf form)
- 33: Leaves not or only weakly discolourous, dark green ..... 34
34. Plants spreading, with thin woody stems up to 0.6 cm thick at the base; leaves densely stellate-hairy when young, sparsely so with age; glandular hairs sessile; seed reticulation fine, reticulae 60–110 µm across, mostly ± rounded ..... *S. leopoldense*
- 34: Plants erect, with thick woody stems up to 2–3 cm thick at the base; leaves consistently densely stellate-hairy; glandular hairs stalked; seed reticulation very fine, reticulae 50–80 µm across, ± elongate ..... *S. zoeae*
35. Leaf lobes 3–5 or 7–14, oblong to broadly triangular ..... 36
- 35: Leaf lobes 4–14, linear ..... 37

36. Leaf lobes 3–5 ..... *S. aff. carduiforme*
- 36: Leaf lobes 7–14 ..... *S. zoeae*
37. Leaves 3–6 cm long, green, the lobes 2–20 mm long, 1–3 mm wide ..... *S. cataphractum*
- 37: Leaves 9–25 cm long, silvery, the lobes 10–170 mm long, 5–10 mm wide ..... *S. tudununggae*
38. Fruiting calyx surrounding or enclosing at least three-quarters of berry (sometimes split) ..... 39
- 38: Fruiting calyx not enclosing berry ..... 67
39. Berry mostly enclosed in or surrounded by lobes of persistent calyx ..... 40
- 39: Berry mostly enclosed in enlarged calyx tube ..... 44
40. Glandular hairs present on calyx of bisexual flower;  
berry 15–20 mm diam., slightly bilobed ..... *S. oedipus*
- 40: Glandular hairs usually absent; berry 20–40 mm diam., globular or ellipsoid ..... 41
41. Fruiting calyx lobes triangular to broadly angular, 10–25 mm long ..... *S. beagleholei*
- 41: Fruiting calyx lobes narrowly triangular, linear,  
or triangular with a linear tip, 20–50 mm long ..... 42
42. Bisexual flower 40–50 mm diam.; male flowers 30–40 mm diam.;  
fruiting pedicel to 25 mm long ..... *S. phlomoides*
- 42: Bisexual flower 30–35 mm diam.; male flowers 20–25 mm diam.;  
fruiting pedicel 25–45 mm long ..... 43
43. Lower leaves shallowly lobed or entire; anthers basifixated,  
filaments 0.5–1.5 mm long; mature fruits globular, internal cavity dry ..... *S. chippendalei*
- 43: Lower leaves deeply lobed; anthers dorsifixated,  
filaments (1.6–)2.0–3.3 mm long; mature fruits mostly longer  
than broad, internal cavity liquid-filled ..... #*S. succosum*
44. Leaves lobed ..... 45
- 44: Leaves entire or slightly undulate ..... 55
45. Flowers solitary, rarely numerous with basal one bisexual and upper ones male ..... 46
- 45: Flowers 1–15 on each peduncle but never regularly 1, usually all bisexual ..... 53
46. Lobes cut almost to midrib ..... 47
- 46: Lobes cut no more than half way to midrib ..... 50
47. Leaf lobes 3–5 or 7–14, oblong to broadly triangular ..... 58
- 47: Leaf lobes 4–14, linear ..... 49
48. Leaf lobes 3–5 ..... *S. aff. carduiforme*
- 48: Leaf lobes 7–14 ..... *S. zoeae*
49. Leaves 3–6 cm long, green, the lobes 2–20 mm long, 1–3 mm wide ..... *S. cataphractum*
- 49: Leaves 9–25 cm long, silvery, the lobes 1–17 cm long, 5–10 mm wide ..... *S. tudununggae*
50. Leaves dull green or yellow-green, sometimes discolourous,  
the lobes broadly triangular ..... *S. heteropodium*
- 50: Leaves green, concolourous, the lobes tooth-like or narrowly triangular ..... 51

- 51.** Leaves glabrous or nearly so; glandular hairs absent; lobes narrow-linear ..... **S. cataphractum**
- 51:** Leaves pubescent with minute stellate and glandular hairs; lobes triangular ..... **52**
- 52.** Plants spreading, with thin woody stems up to 0.6 cm thick  
at the base; leaves densely stellate-hairy when young, sparsely  
so with age; glandular hairs sessile; seed reticulation fine, ± rounded ..... **S. leopoldense**
- 52:** Plants erect, with thick woody stems up to 2–3 cm thick at the base;  
leaves consistently densely stellate-hairy; glandular hairs stalked;  
seed reticulation very fine, ± elongate..... **S. zoeae**
- 53.** Indumentum on stems, calyx and young shoots rusty red or orange-brown..... #**S. gilesii**
- 53:** Indumentum on all parts grey-green, yellow-green or purple-green..... **54**
- 54.** Stems erect or almost so..... **S. lasiophyllum**
- 54:** Stems prostrate or sprawling..... **S. lucani**
- 55.** Flowers always solitary ..... **56**
- 55:** Flowers 2–15 on each peduncle ..... **61**
- 56.** Leaves usually 1–1.5 cm wide ..... **57**
- 56:** Leaves usually 2–7 cm wide ..... **59**
- 57.** Leaves concolourous, silvery green, 15–20 cm long;  
calyx with scattered prickles ..... **S. tudununggae**
- 57:** Leaves discolourous, mostly 3–7 cm long; calyx densely prickly..... **58**
- 58.** Leaves usually with rusty hairs over a green blade, lanceolate-elliptic;  
berry c. 20 mm diam..... **S. cunninghamii**
- 58:** Leaves never as above, lanceolate; berry 15–20 mm diam..... **S. petraeum**
- 59.** Fruiting pedicel to 15 mm long, erect; fruit splitting around  
circumference to form a loose cap ..... **S. vansittartense**
- 59:** Fruiting pedicel 15–30 mm long, deflexed or nodding;  
fruit not splitting around circumference ..... **60**
- 60.** Indumentum silvery (type form) or rusty (W Kimberley form)..... **S. dioicum**
- 60:** Indumentum greenish white..... **S. sp. Longini**
- 61.** Stems prostrate or sprawling..... **62**
- 61:** Stems erect or almost so..... **64**
- 62.** Stellate hairs 0.3–0.6 mm diam. on branchlets and petioles, the central ray  
0.3–1.2 × length of lateral rays; all stellate hairs on fruiting calyx  
with stalks <0.5 mm long; proto-prickles absent ..... **S. fecundum**
- 62:** Stellate hairs 0.6–1.1 mm diam. on branchlets and petioles, the  
central ray 1–1.8 × length of lateral rays; some stellate hairs on  
fruiting calyx with stalks >0.8 mm long, proto-prickles sometimes present ..... **63**
- 63.** Leaves slightly discolourous; petioles 25–55% of lamina length;  
average of 10–66 prickles per cm on branchlets; leaf margins  
often repand (wavy); calyx lobes 2.5–6 mm long at anthesis ..... **S. echinatum**
- 63:** Leaves distinctly discolourous; petioles 55–115% of lamina length;  
average of 0.3–8 prickles per cm on branchlets;  
leaf margins entire; calyx lobes 1–2.5 mm long at anthesis..... **S. lucani**

64. Indumentum bright rusty or orange-brown ..... 65
- 64: Indumentum grey-green, yellow-green or white ..... 66
65. Inflorescence 2–5-flowered; peduncle to 4 cm long; berry depressed-globular, squarish in outline ..... *S. echinatum*
- 65: Inflorescence 1- or 2-flowered; peduncle to 0.5 cm long; berry globular, circular in outline ..... #*S. gilesii*
66. Leaves concolourous; berry globular or ovoid, rarely conical or ellipsoid, yellow ..... *S. lasiophyllum*
- 66: Leaves discolourous; berry depressed-globular, squarish in outline, pale green ..... *S. echinatum*
67. Berry red, orange-red or blackish red ..... 68
- 67: Berry green, yellow or purple, often drying to brown or black ..... 69
68. Leaves linear or nearly so, 2–14 mm wide ..... *S. ferocissimum*
- 68: Leaves lanceolate, elliptic or ovate, 10–140 mm wide ..... #*S. chenopodinum*
69. Inflorescence forked ..... *S. beagleholei*
- 69: Inflorescence simple ..... 76
70. Berry 30–40 mm wide, yellow ..... *S. phlomoides*
- 70: Berry up to 30 mm wide, green, yellow or brown ..... 71
71. Lowest flower of inflorescence bisexual, the others male; berry 15–30 mm diam., always solitary; seeds black ..... 72
- 71: Flowers all bisexual, rarely lower ones bisexual, upper ones male; berry usually less than 15 mm diam.; seeds not black ..... 78
72. Leaves entire or shallowly lobed with several basal lobes ..... 73
- 72: Leaves deeply lobed, cut more than half way to midrib ..... 76
73. Fruiting calyx lobes triangular to broadly angular, 10–25 mm long ..... *S. beagleholei*
- 73: Fruiting calyx lobes narrowly triangular, linear, or triangular with a linear tip, 20–50 mm long ..... 74
74. Bisexual flower 40–50 mm diam.; male flowers 30–40 mm diam.; fruiting pedicel to 25 mm long ..... *S. phlomoides*
- 74: Bisexual flower 30–35 mm diam.; male flowers 20–25 mm diam.; fruiting pedicel 25–45 mm long ..... 75
75. Lower leaves shallowly lobed or entire; anthers basifixd, filaments 0.5–1.5 mm long; mature fruits globular, internal cavity dry ..... *S. chippendalei*
- 75: Lower leaves deeply lobed; anthers dorsifixd, filaments (1.6–)2.0–3.3 mm long; mature fruits mostly longer than broad, internal cavity liquid-filled ..... #*S. succosum*
76. Fruiting calyx lobes broadly triangular, appressed ..... *S. diversiflorum*
- 76: Fruiting calyx lobes narrow, triangular to elliptic, not appressed ..... 77
77. Lower leaf lobes often cut 2–3 mm from midrib; flowering calyx to 10 mm long; fruiting calyx lobes 1–1.5 cm long ..... *S. eburneum*

- 77: Lower leaf lobes rarely cut 2–3 mm from midrib;  
flowering calyx 10–30 mm long; fruiting calyx lobes 2–2.5 cm long ..... **S. chippendalei**
- 78: Leaves shallowly lobed ..... **S. esuriale**
- 78: Leaves entire or slightly undulate ..... 79
- 79: Berry dry, yellow, finally brown or black ..... **S. centrale**
- 79: Berry bony or mucilaginous, yellow, green, purple or orange-brown ..... 80
- 80: Berry hard and bony, the lower half enclosed by the calyx ..... **S. quadriloculatum**
- 80: Berry succulent, the lower half not enclosed by the calyx ..... 81
- 81: Calyx 2–3 mm long; stellate hairs on the foliage minute ..... #**S. tumulicola**
- 81: Calyx 4–8 mm long; stellate hairs not minute ..... **S. esuriale**

\*Naturalised in the Kimberley region.

#Not yet recorded in the Kimberley region, but probably present and included here to facilitate identification.

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## Four new species of *Astrolooma* (Ericaceae: Styphelioideae: Stypheliae) from Western Australia

Michael Hislop<sup>1</sup>, Annette J.G. Wilson<sup>2</sup> and Caroline Puente-Lelièvre<sup>3</sup>

<sup>1</sup>Western Australian Herbarium, Department of Environment and Conservation,

Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

<sup>2</sup>Australian Biological Resources Study, G.P.O. Box 787, Canberra,

Australian Capital Territory 2601

<sup>3</sup>James Cook University, Cairns Campus, P.O. Box 6811, Cairns, Queensland 4870

### Abstract

Hislop, M., Wilson, A.J.G. & Puente-Lelièvre, C. Four new species of *Astrolooma* (Ericaceae: Styphelioideae: Stypheliae) from Western Australia. *Nuytsia* 23: 23–42 (2013). Four new species of *Astrolooma* R.Br. s. str. (*A. acervatum* Hislop & A.J.G.Wilson, *A. chloranthum* Hislop & A.J.G.Wilson, *A. inopinatum* Hislop and *A. oblongifolium* A.J.G.Wilson & Hislop) are described, illustrated and mapped. The current taxonomic status of *Astrolooma* is discussed in the light of significant changes that are pending in the *Styphelia* clade to which the genus belongs. A key to members of *Astrolooma* s. str. with pale yellow, cream and/or green flowers is provided.

### Introduction

The current circumscription of the small Australian genus *Astrolooma* R.Br. is largely unchanged from that used by Bentham in *Flora Australiensis* (1868). Bentham's treatment represented an expansion of Brown's (1810) original generic concept to include taxa first described in *Stenanthera* R.Br. (*Astrolooma pinifolium* (R.Br.) Benth. and *Astrolooma conostephoides* (Sond.) Benth.) and *Stomarrhena* DC. (*Astroloma xerophyllum* (DC.) Sond.). He also accepted two other morphologically anomalous species, *A. stomarrhena* Sond. and *A. baxteri* DC. In the last 25 years a growing body of research (Powell *et al.* 1987; Powell *et al.* 1997; Streiber 1999; Quinn *et al.* 2003; Puente-Lelièvre *et al.* unpublished) has provided strong evidence that as so constituted the genus is polyphyletic. A molecular study of relationships across the tribe *Stypheliae* Bartl. by Quinn *et al.* (2003) utilized DNA sequence data from two plastid regions, *matK* gene and the *atpB-rbcL* intergenic spacer. Cladistic analyses of the combined data from these two regions yielded a phylogenetic tree that showed species currently assigned to *Astrolooma* grouping in five different areas of the tree. Three of these groupings, including the *Astrolooma* s. str. subclade, were nested within a larger clade (referred to as the *Styphelia* clade) which also included species of *Styphelia* Sm., *Coleanthera* Stschegl., *Croninia* J.M. Powell and the majority of *Leucopogon* R.Br. segregate taxa (i.e. excluding *Leucopogon* s. str. which is outside of the *Styphelia* clade). The level of support for these potential generic groupings was mixed but at least for the *Astrolooma* s. str. subclade it was relatively weak. Other relationships within this clade were also inadequately resolved and the need for further research was recognised before any final decisions could be taken regarding the potential splitting of *Astrolooma* and the other two polyphyletic genera, *Styphelia* and *Leucopogon*. The third author is currently finalising a PhD project with the primary aim

of resolving these phylogenetic relationships and delimiting generic boundaries in this taxonomically complex clade. Molecular phylogenies have been estimated based on four chloroplast (*atpB-rbcL*, *matK*, *rbcL* and *trnH-psbA*) and one nuclear (ITS) loci. The new study has largely confirmed and strengthened the topology obtained by Quinn *et al.* (2003) as it pertained to the various elements of *Astrolooma*. The overall taxonomic implications of the latest research are challenging and will be discussed in a forthcoming paper (Puente-Lelièvre *et al.* unpublished). A final decision has yet to be made regarding the most appropriate generic framework to reflect the complex patterns of morphological and genetic diversity contained within the *Styphelia* clade. A conservative approach would potentially see all members of the clade, including *Astrolooma s. str.*, subsumed into a greatly expanded *Styphelia*, although it is more likely that *Astrolooma* will be retained with a reduced circumscription. In the latest analyses of the combined molecular data (Puente-Lelièvre *et al.* unpublished) the *Astrolooma s. str.* clade is consistently supported.

From a morphological perspective *Astrolooma s. str.* is well-defined and can be recognised by the following character combination: corolla various shades of red, pink or orange, or pale yellow, cream and/or green (never white); corolla tube usually with a whorl of hairs close to the base on the inner surface; corolla lobes erect basally and spreading or recurved in the upper one quarter to one third, usually bitextured, with the distal one third to one half of the lobes abruptly smoother and paler than the basal portion; filaments flattened (linear in section) or occasionally compressed (narrowly elliptic in section); anthers partially included within the tube. Of these characters the bitextured corolla lobes represents a synapomorphy for the genus (it is only absent from *A. macrocalyx* Sond.).

Based both on their morphology and position in the phylogenetic tree the new species described below are members of *Astrolooma s. str.* Although, as outlined above, the taxonomic status of the members of this clade may change, they are published here under *Astrolooma* rather than *Styphelia* for reasons of convenience. The genus is a long-accepted one and, at least when circumscribed to include only members of *Astrolooma s. str.*, has morphological and molecular integrity. If ongoing research does ultimately conclude that *Astrolooma* is better recognised as a subgenus under *Styphelia* then new combinations can be made for these four species at the same time as for the several other taxa in *Astrolooma* for which names are currently lacking under *Styphelia*. The specific epithets used here are not occupied in *Styphelia*.

The majority of species in *Astrolooma s. str.* have corollas which are shades of red, pink or orange, but six species have pale yellow, cream or green corollas. Three of these six are formally described in this paper. They had all been previously identified as *A. pallidum* R.Br. which remains a widespread and variable species even after the segregation of the new taxa. The other species described here, *A. inopinatum*, is red-flowered. A key to the yellow, cream or green-flowered taxa in *Astrolooma* is provided below, as all known taxa in this group are now described. The taxonomy of those species with red, pink or orange coloured flowers is still incomplete and it would therefore be premature to include a key to those at this stage.

## Methods

This study was based on examination of dried specimens housed at PERTH together with extensive field observations of the genus, including the four new species described below.

Foliar measurements were taken from dried specimens. Leaf thickness was measured at the midrib, half way along the lamina. Observations of leaf venation were made from mature leaves only. Across the

tribe *Stypheliae* generally it is common for young leaves to show prominently raised venation on the abaxial surface which is much less evident, if at all, at maturity. Similarly, the first leaves produced at the beginning of a growth flush should be ignored. The lowest of these are clearly bract-like, but there is a morphological transition across several nodes before the form of the mature leaves is reached.

Inflorescence length is measured from the insertion point in a leaf axil to the tip of the bud rudiment. Floral measurements were taken from re-hydrated flowers. The recurved corolla lobes were straightened prior to measuring. Sepal width was measured in natural posture, i.e. they were not flattened out. This method was preferred because their curvature can be so extreme that they are liable to either split or become pleated when attempts are made to flatten them.

## Taxonomy

### Key to species of *Astroloma* s. str. with pale yellow, cream and/or green flowers

1. Leaves convex adaxially, the margins recurved to revolute; sepal margins manifestly ciliate at least in the upper half, with hairs to 0.7 mm long (northern Darling Range in the Bindoon–New Norcia area and Geraldton Sandplains between Cataby and Eneabba) ..... ***A. oblongifolium***
- 1: Leaves concave adaxially, the margins never revurved; sepal margins eciliate or minutely ciliolate in *A. tectum* and *A. macrocalyx*
  2. Longest leaves usually at least 20 mm long, but if less, then the widest leaves at least 6 mm wide; staminal filaments compressed only (i.e. narrowly elliptic in section)
    3. Leaves very narrowly ovate, widest leaves to c. 4 mm wide; sepals longer than the corolla tube, >13 mm long (mostly on the Swan Coastal Plain Darling Range from Regans Ford to the Perth region with scattered occurrences inland as far south as the Katanning area) ..... ***A. macrocalyx***
    - 3: Leaves elliptic or narrowly elliptic, widest leaves at least 6 mm wide; sepals shorter than corolla tube, 7–10 mm long (near-south-coast localities between Albany and Cape Arid and inland as far as the Stirling Range and Mt Ragged) ..... ***A. tectum***
  - 2: Longest leaves to c. 20 mm long and widest to c. 5 mm wide; staminal filaments manifestly flattened (i.e. linear in section)
    4. Corolla bright green throughout; leaves narrowly obovate to obovate, ± abruptly contracted towards the apical mucro (restricted distribution in the south-eastern wheatbelt between Newdegate and Pingrup) ..... ***A. chloranthum***
    - 4: Corolla mostly cream or very pale yellow, the tube sometimes greenish cream in the lower half; leaves elliptic to narrowly obovate-elliptic, gently tapering towards the apical mucro
      5. Plants with a fire-sensitive rootstock, prostrate and mat-forming, or becoming raised and mounded in the centre, but always tapering toward a well-defined margin at soil level; aspect bright green; mature leaf margins conspicuously pale and hyaline; sepal mucro to 0.15 mm long (eastern Darling Range and adjacent parts of the western wheatbelt) ..... ***A. acervatum***
      - 5: Plants with a fire-resistant rootstock, of irregular form, ± erect, but usually low and spreading, not prostrate or mat-forming, nor tapering to a well-defined margin at soil level; aspect glaucous; mature leaf margins not pale and hyaline; sepal mucro >0.20 mm long (widespread in the wetter parts of south-western Australia from Mt Lesueur in the north to the Wellstead area, east of Albany) ..... ***A. pallidum***

## Descriptions

### **Astrolooma acervatum** Hislop & A.J.G.Wilson, sp. nov.

*A. pallido* affinis sed caudice non-ligno-tuberoso, habitu denso rotundato, foliis viridibus non glaucis, marginibus hyalinis, et mucronibus sepali brevioribus.

*Typus*: Lower Hotham Road, 3.9 km north of Harvey–Quindanning Road, north-west of Quindanning, Western Australia, 14 September 2010, M. Hislop 4077 (*holo*: PERTH 08253692; *iso*: CANB, NSW).

*Astrolooma* sp. Tutanning (A.S. George 7779), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed March 2012].

Very dense *shrubs*, prostrate and mat-forming, but the centre often becoming raised and mounded with age, to 15 cm high and at least 120 cm wide, from a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of ± patent, straight or variously curled hairs to 0.6 mm long, but usually shorter. *Leaves* antrorse, usually steeply so, narrowly obovate-elliptic, 10–17 mm long, 1.8–3.3 mm wide; apex long-mucronate, pungent, the mucro 0.9–1.5 mm long; base attenuate; petiole rather indistinct, creamy yellow or greenish yellow, c. 0.5–1.0 mm long, glabrous or with a few hairs on the adaxial surface and margins; lamina 0.25–0.35 mm thick, concave adaxially, longitudinal axis ± straight, gently incurved or gently recurved; surfaces distinctly discolored; adaxial surface shiny, glabrous, or sparsely hairy towards the base, venation either not evident, or 1–3 sunken lines sometimes visible, mostly in the lower half; abaxial surface paler, shiny, glabrous, with 3–5 rather conspicuous, white, flat or raised, primary veins, and significant secondary development, the midrib no more prominent than the others; margins of mature leaves conspicuously pale and hyaline, coarsely ciliolate with stiff, antrorse hairs (26–56 along each margin), 0.05–0.25 mm long. *Inflorescences* erect; axis 2.5–3.6 mm long, single-flowered. *Fertile bract* broadly elliptic, ± orbicular to transversely elliptic, 1.6–2.4 mm long, 1.7–2.4 mm wide, subtended by 8–12 variously shaped, smaller sterile bracts. *Bracteoles* ovate to elliptic, 2.3–3.4 mm long, 2.1–2.5 mm wide, obtuse, mucronate, the mucro 0.05–0.20 mm long, abaxial surface glabrous, straw-coloured, occasionally flushed pink towards the apex, multi-veined and striate, becoming scarious towards the margins; adaxial surface glabrous; margins glabrous. *Sepals* narrowly ovate, 5.0–6.7 mm long, 2.1–2.5 mm wide, obtuse, mucronulate, the mucro 0.05–0.15 mm long; abaxial surface glabrous, mostly straw-coloured, but sometimes greenish towards the base and/or flushed pink towards the apex, conspicuously striate with 11–15 raised veins, becoming scarious towards the margins; adaxial surface glabrous except for a discrete patch of hairs close to the base, at least on the inner sepals; margins glabrous. *Corolla tube* cream towards the apex, becoming greenish cream in the lower half, cylindrical, or very narrowly campanulate, much exceeding the sepals, 10.4–14.5 mm long, 2.8–3.6 mm wide, internal surface with a ± continuous whorl of dense hairs in the lower half (2.8–4.5 mm above the base), the hairs 0.9–1.5 mm long and issuing from unmodified tissue, hairs also scattered in the tube above the tufts, especially towards the throat. *Corolla lobes* erect in the lower 2/3–3/4, recurved above, cream, always shorter than the tube (ratio = 0.33–0.50:1), 3.6–6.0 mm long, 1.5–2.2 mm wide at base; the indumentum of the central portion of the internal surface 0.8–1.4 mm long; glabrous tips 0.20–0.35 mm long. *Anthers* partially exserted from the tube (by 3/4–7/8 of their length), 2.0–2.5 mm long, apex deeply emarginate. *Filaments* flat, 1.0–1.5 mm long, 0.3–0.7 mm wide, attached c. 3/4 above anther base. *Nectary* annular 0.6–1.0 mm long, irregularly lobed for up to 1/4 of length. *Ovary* ovoid to ellipsoid, 1.1–1.4 mm long, 1.0–1.3 mm wide. *Style* 13.4–18.4 mm long, scabrous in the upper half. *Fruit* ellipsoid to ± globose, 5.5–8.0 mm long, 5.0–7.0 mm wide, much longer than the calyx, the surface deeply rugose when dry. (Figures 1, 2)

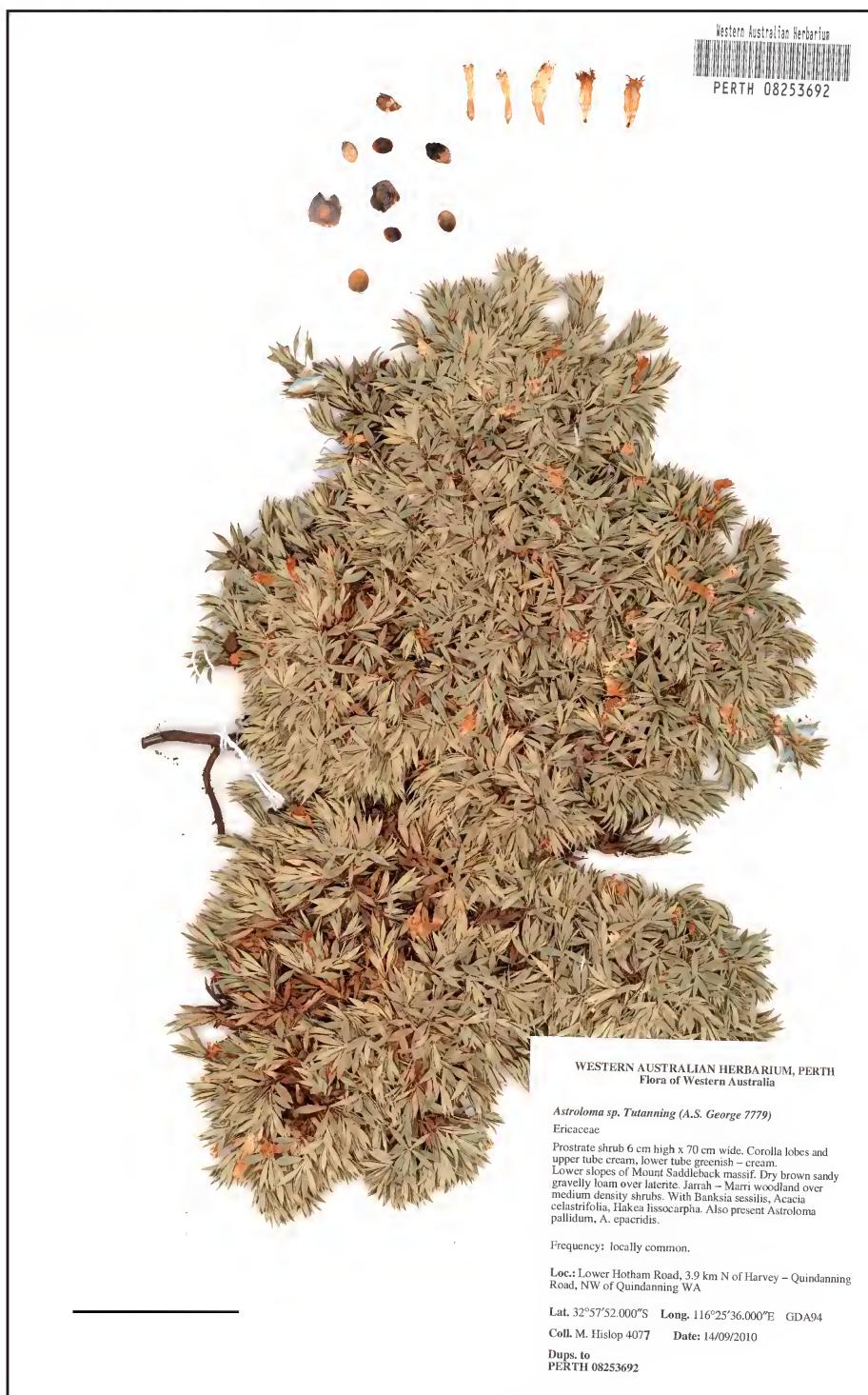


Figure 1. Scan of holotype of *Astroloma acervatum* (PERTH 08253692). Scale = 5 cm.



Figure 2. *Astroloma acervatum*. A – habit, B – leaves and flowers (F. & J. Hort 3660). Photographs by J. Hort.

*Other specimens examined.* Ricks Rd 6.3 km E of North Bannister–Wandering Rd, N of Wandering, 21 Aug. 2010, M. Hislop 4044 (CANB, MEL, PERTH); Lupton Conservation Park, E boundary firebreak adjacent to Woods Loop, W of Brookton, 23 Aug. 2010, M. Hislop 4049 (PERTH); Brookton Highway Nature Reserve, perimeter firebreak, E of Coles Rd, W of Brookton, 23 Aug. 2010, M. Hislop 4050 (CANB, NSW, PERTH); Bannister–Marradong Rd, 3.2 km N of Robins Rd, S of Boddington, 4 Sep. 2010, M. Hislop 4051 (PERTH); W boundary of Mooradung Nature Reserve, 600 m S of Lucev Rd, SE of Boddington, 4 Sep. 2010, M. Hislop 4052 (CANB, PERTH); site 233. [Private property], off W end of Pike Rd, W of Brookton, 30 Sep. 2008, M. Hislop & M. Griffiths WW 233-36 (PERTH); site 235. [Private property], W side of Hillcroft Rd between Dale Rd South and Groves Rd, W of Brookton, 1 Oct. 2008, M. Hislop & M. Griffiths WW 235-33 (PERTH); site 237. [Private property], S of Edison Mill Rd between Dobaderry and Rogers Rd, W of Beverley, 3 Oct. 2008, M. Hislop & M. Griffiths WW 237-44 (PERTH); site 232. [Private property], E side of Bicker Rd, opposite intersection with Tutanning Rd, E of Pingelly, 25 Sep. 2008, M. Hislop & H. Mills WW 232-34 (PERTH); Wearne State Forest, Wandering, Ricks Rd, 4.2 km E from South Rd, and then the track N for 50 m, 28 Aug. 2010, F. & J. Hort 3660 (CANB, NSW, PERTH); Fox's Lair, Narrogin, 15 Sep. 1992, J.P. Pigott JPP 1504 (PERTH); Wearne Rd, 15.8 km E from Albany Highway [E of North Bannister], 2 July 2010, C. Puente-Lelièvre, M. Hislop & E.A. Brown CPL 36 (NSW, PERTH).

*Distribution and habitat.* A regional endemic restricted to the eastern Darling Range and adjacent parts of the western wheatbelt from west of Beverley to the Narrogin area and as far east as Tutanning Nature Reserve, east of Pingelly (Figure 3). *Astroloma acervatum* mainly occurs high in the landscape in sandy loam soils over laterite and in association with woodlands dominated by *Eucalyptus accedens*, *E. marginata*, *E. wandoo* and *E. astringens*. It favours open sites where there is limited competition from other shrubs.

*Phenology.* The main flowering period is between July and September, although sporadic flowering apparently occurs at other times of the year, probably depending on available moisture. Fruit appears to be retained on the plants for many months. It is likely to be present for much of the year but with a peak between October and March.

*Etymology.* From the Latin *acervatus* (mounded or heaped), a reference to the distinctive growth habit of the species.

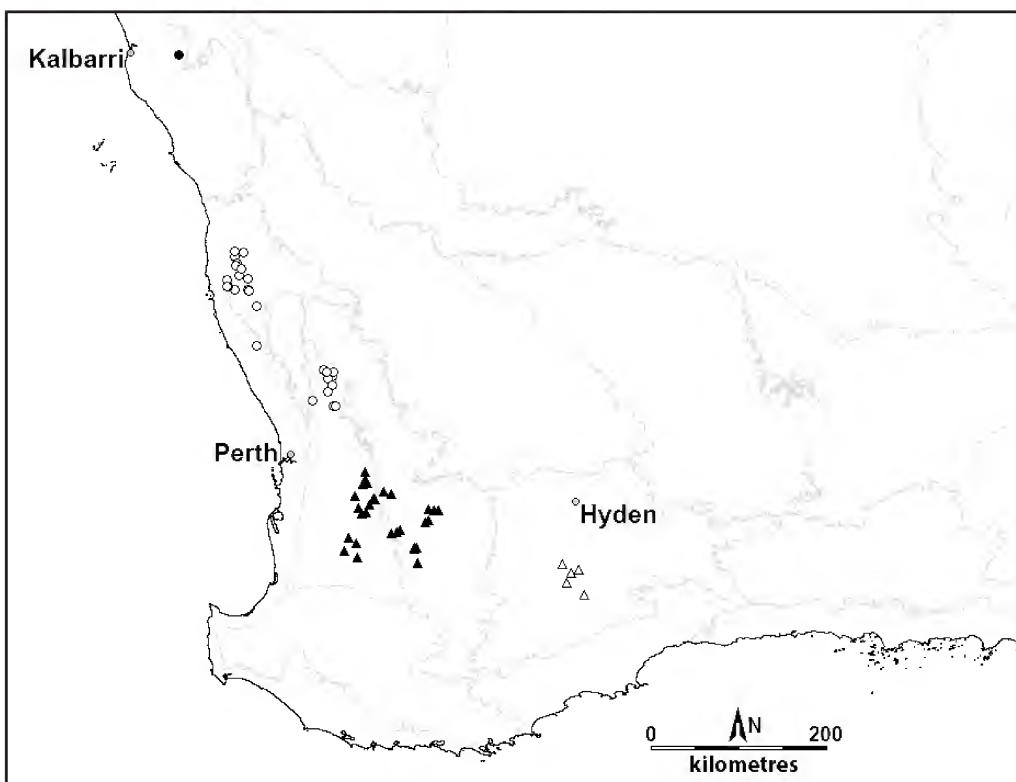


Figure 3. Distribution of *Astroloma acervatum* (closed triangle), *A. inopinatum* (closed circle), *A. oblongifolium* (open circle) and *A. viridis* (open triangle) in Western Australia.

*Conservation status.* Although the distribution of *A. acervatum* is not extensive, it is known to occur in a number of Nature Reserves and National Parks and its preferred habitat is common across the species' range. No conservation coding is recommended here.

*Affinities.* Collections of this species have hitherto mostly been assigned to *Astroloma pallidum*, which shares similar-coloured flowers and a low growth habit (Figure 4). The two are often sympatric in the same habitat across the range of *A. acervatum*, although there is no evidence of hybridisation between them.

In addition to the characters used in the key above there are a couple of other less clear-cut, but still useful, differences between the two. Relative to the leaves of *A. acervatum*, those of *A. pallidum* generally have fewer (frequently <25 per margin), but longer (often >0.25 mm long), marginal hairs. Whereas the abaxial sepal surfaces are always glabrous in *A. acervatum*, they are often shortly hairy in *A. pallidum*.

Although the two species produce flowers over many months of the year, there is a significant difference in the detail of their flowering patterns. At sites where they co-occur, when *A. acervatum* is at peak flowering between mid-July and mid-September, plants of *A. pallidum* are either not flowering at all or have very few flowers present. Conversely between October and December when *A. pallidum* is in full flower, flowering plants of *A. acervatum* are scarce.



Figure 4. *Astroloma pallidum*. A – habit; B – leaves and flowers (M. Hislop 4099). Photographs by M. Hislop.

Sterile or fruiting plants could be mistaken for the red-flowered *A. compactum* R.Br. (Figure 5), another species which frequently co-occurs with *A. acervatum*. The former generally has a similar prostrate, mat-forming habit, but plants do not become mounded and the leaves are smaller, more obviously obovate (i.e. the widest part of the leaf is closer to the apex), and lack the characteristic pale margins of *A. acervatum*.

Immediately to the south of the known range of *A. acervatum*, there occurs a plant with the same hyaline leaf margins and a very similar habit to that species, but which differs in ways that are of potential taxonomic significance. Currently known only from very few collections from near Darkan (e.g. M. Hislop 4065) and Collie, it has pink flowers, apparently longer sepals and a generally taller habit, although still with the characteristically tapered and well-defined margins of typical *A. acervatum*. This entity is not included in the above description. Further collections and field observations are required in order to verify that these differences are consistent and whether taxonomic recognition is warranted.

*Notes.* The area of the eastern Darling Range and adjacent parts of the western wheatbelt to which *A. acervatum* is endemic is the richest in Western Australia for the genus *Astroloma*. In addition to the new species, and the already-mentioned *A. pallidum* and *A. compactum*, another four are known to occur here (i.e. *A. ciliatum* (Lind.) Druce, *A. drummondii* Sond., *A. epacridis* (DC.) Druce and *A. serratifolium* (DC.) Druce *s. str.*) and sometime as many as five species can be observed growing at the same site.

Although the drupes of all species of *Astroloma* *s. str.* have a significant mesocarp, those of *A. acervatum* are particularly well-developed and can be as much as 12 mm wide at maturity. At that stage they have a strong, sweet odour.



Figure 5. *Astroloma compactum*. Leaves and flowers (unvouchered). Photograph by J. Hort.

**Astrolooma chloranthum** Hislop & A.J.G. Wilson, *sp. nov.*

*A. compacto* affinis sed floribus viridibus, habito humilis effuso (non prostrato), mucronibus folii longioribus, mucronibus bracteolii et sepallii brevioribus differt.

*Typus*: west of Newdegate [precise locality withheld for conservation reasons], Western Australia, 23 April 2006, M. Hislop 3584 (*holo*: PERTH 07524013; *iso*: CANB, NSW).

Very low, spreading *shrubs* to c. 10 cm high and 100 cm wide, multi-stemmed at ground level from a rootstock which is probably fire-tolerant. Young *branchlets* with a sparse indumentum of patent, straight hairs to c. 0.1 mm long. *Leaves* steeply antrorse, narrowly obovate to obovate, 7.8–13.5 mm long, 1.8–3.6 mm wide; apex long-mucronate, pungent, the mucro 1.4–2.0 mm long; base attenuate; petiole rather indistinct, yellowish green, to c. 0.8 mm long, glabrous or with a few hairs on the adaxial surface and margins; lamina 0.25–0.35 mm thick, concave adaxially, longitudinal axis gently incurved in the basal 1/3, the remainder either straight or gently recurved in the upper 1/3; surfaces discolorous; adaxial surface shiny, bright green, glabrous in the upper half, glabrous or sparsely hairy in the lower, venation not evident; abaxial surface much paler, matt, ± glabrous, with 3–5 flat or slightly raised primary veins and significant secondary development, the midrib becoming wider and more prominent than the others towards the apex; margins of mature leaves not hyaline, or very narrowly so, coarsely ciliolate with short, stiff, antrorse hairs (24–42 along each margin), 0.5–0.15 mm long. *Inflorescences* erect; axis 1.2–2.4 mm long, single-flowered. *Fertile bract* broadly ovate to suborbicular, 1.3–2.2 mm long, 1.3–2.1 mm wide, closely subtended by 4–7 variously shaped, smaller sterile bracts. *Bracteoles* broadly elliptic to suborbicular, 1.7–2.3 mm long, 1.5–1.9 mm wide, obtuse, mucronulate, the mucro 0.05–0.10 mm long; abaxial surface glabrous, striate, pale green to straw-coloured, sometimes tinged pink towards the apex, narrowly scarious towards the margins; adaxial surface glabrous; margins glabrous. *Sepals* ovate or narrowly ovate, 4.0–4.8 mm long, 1.6–2.1 mm wide, obtuse, obscurely mucronulate, the mucro to 0.08 mm long; abaxial surface glabrous, pale green, tinged pink towards the apex, conspicuously striate with 9–11 raised veins, narrowly scarious towards the margins; adaxial surface glabrous except for a discrete patch of hairs close to the base; margins glabrous. *Corolla tube* green, cylindrical, or very narrowly campanulate, much exceeding the sepals, 6.6–10.1 mm long, 2.6–3.0 mm wide, internal surface with a ± continuous whorl of dense hairs in the lower half (2.2–3.0 mm above the base), the hairs 0.8–1.1 mm long and issuing from unmodified tissue, glabrous elsewhere. *Corolla lobes* green, erect in the lower 2/3–3/4, recurved above, always shorter than the tube (ratio = 0.37–0.57:1), 3.4–4.0 mm long, 1.3–1.7 mm wide at base; indumentum of the central portion of the internal surface, 0.6–0.8 mm long, glabrous at the very base; glabrous tips 0.3–0.4 mm long. *Anthers* partially exserted from the tube (by 3/4–7/8 of their length), 1.8–2.2 mm long, apex deeply emarginate. *Filaments* flat, 0.8–1.2 mm long, 0.7–0.8 mm wide, attached c. 3/4 above anther base, tapering towards the apex, anther attachment at apex. *Nectary* annular, 0.4–0.6 mm long, entire or very shallowly and irregularly lobed. *Ovary* ellipsoid, 1.0–1.3 mm long, 0.8–1.0 mm wide. *Style* 10.0–13.2 mm long, shortly scabrous in the upper half. *Fruit* ellipsoid to ± globose, 4.8–5.2 mm long, 3.9–4.8 mm wide, much longer than the calyx, the surface with a shallow, irregular reticulum. (Figure 6)

*Other specimens examined*. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 June 2003, A. Coates AC 4664 (PERTH); 30 May 2010, M. Hislop 4019 (CANB, MEL, PERTH); 31 May 2010, M. Hislop 4022 (NSW, PERTH); 31 Oct. 2000, R. Meissner LB 52 (PERTH).

*Distribution and habitat*. *Astrolooma chloranthum* appears to be restricted to a small area of the south-eastern wheatbelt between Newdegate and Pingrup (Figure 3). It usually occurs low in the landscape in sandy or sandy loam soils, probably with clay at depth, and is associated with mallee woodland where the understorey is typically dominated by various species of *Melaleuca*.



Figure 6. Scan of *Astroloma chloranthum* (PERTH 08213178). Scale = 5 cm.

**Phenology.** The onset of flowering is likely to be determined by soil moisture levels, but in average seasonal conditions peak flowering is probably between April and June, later if autumn rainfall has been light. Mature fruit has been collected in late June and could be expected to be present for much of the second half of the year.

**Etymology.** From the Greek *chloros* (green) and *anthos* (flower).

**Conservation status.** To be listed as Priority Two under DEC Conservation Codes for Western Australian Flora (M. Smith pers. comm.). Although all but one of the five known populations of this species are either in Nature Reserves or Water Reserves, the four observed by the author were small (<12 individuals) and very scattered. In addition dead plants were noted at each of the sites. The hotter summers and reduced rainfall that have been experienced in much of inland south-western Australia in recent decades are expected to be only a forerunner of more extreme conditions in the future (Watterson *et al.* 2007). This climatic scenario presumably represents an active threatening process for many plant species, but local endemics such as *A. chloranthum* would appear to be particularly vulnerable.

**Affinities.** Because of its similar leaf shape the species most likely to be confused with *A. chloranthum* is the widespread, red-flowered *A. compactum*. In addition to flower colour, *A. chloranthum* differs from that species in the following ways: has a low, spreading rather than strictly prostrate habit (but refer to next paragraph for a possible exception); a longer leaf mucro (1.4–2.0 mm compared to 0.6–1.4 mm in *A. compactum*); shorter bracteole and sepal mucros (0.05–0.10 mm and 0.02–0.08 mm respectively, as against 0.10–0.50 mm and 0.10–0.50 mm for *A. compactum*); corolla lobes which are glabrous at the base and with the inner corolla tube completely glabrous above the hair whorl, rather than the lobe bases having a sparse indumentum with a few hairs extending well into the throat of the corolla tube, which is the case for *A. compactum*. *Astroloma chloranthum* has a more inland distribution than *A. compactum*. On the basis of current knowledge the closest populations of the latter occur in the southern part of Lake Magenta Nature Reserve about 60–70 km south of the southernmost known population of *A. chloranthum*.

In aspects of its leaf morphology *A. compactum* is rather variable, and this variation has some geographical basis. Plants from the Darling Range (Figure 5), especially in the north, have narrower, more spatulate leaves which tend to have fewer and longer marginal hairs relative to those from the Great Southern district. A variant from the south coast (e.g. J.M. Powell 3313), which probably represents the type form, has glaucous or blue-green leaves which are more attenuate towards the apex and a corolla with somewhat denser hairs in the throat. Collecting notes suggest that, at least in some populations, this variant may have a low, ascending habit. In its foliar morphology *A. chloranthum* is most similar to those populations of *A. compactum* from the Great Southern district. DNA data; however, does not support any particularly close relationship between these two species (Puente-Lelièvre *et al.* unpublished).

**Notes.** Outside of the genus *Acrotriche* R.Br., where green flowers are the norm, the only other Australian epacrids that have uniformly green corollas are *Styphelia viridis* Andrews and *Brachyloma scorTechinii* F.Muell., both from New South Wales and southern Queensland. However, another locally endemic Western Australian species of *Astroloma*, *A. foliosum* Sond., has corolla lobes which are black in the basal half and bright green above. This is an important feature in distinguishing it from its close relative *A. ciliatum*, in which both the lobes and the tube are red. *Astroloma pinifolium* often has a multi-coloured corolla with combinations of yellow and green and/or red.

***Astroloma inopinatum* Hislop, sp. nov.**

*A. glaucescens* affinis sed habito grandiore, foliis rectis ellipticis (non linearibus convolutis) et floribus patentibus vel pendulis.

*Typus*: east of Kalbarri, Western Australia [precise locality withheld for conservation reasons], 24 July 2008, M. Hislop & G. Phelan MH 3778 (*holo*: PERTH 08056889; *iso*: CANB, NSW).

*Astroloma* sp. Galena (G. Phelan & A. Chant 9), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed March 2012].

Robust, spreading *shrubs* to 1.8 m high and 1.8 m wide, from a well-developed rootstock which is probably fire-tolerant. Young *branchlets* with a sparse to moderately dense indumentum of very short, patent hairs, c. 0.02 mm long. *Leaves* usually variably antrorse, but sometimes ± patent, narrowly elliptic, 11–24 mm long, 1.9–3.6 mm wide; apex long-mucronate, pungent, the mucro 1.0–1.6 mm long; base attenuate; petiole moderately distinct, creamy yellow, 0.6–1.1 mm long, glabrous or with a few hairs on the adaxial surface; lamina 0.35–0.45 mm thick, concave adaxially, longitudinal axis ± straight, or gently incurved; surfaces glaucous, ± concolorous, or with the abaxial surface very slightly paler; adaxial surface matt or becoming shiny on older leaves though abrasion, glabrous throughout or sparsely hairy towards the base, venation not evident; abaxial surface matt, glabrous, with 5–7 conspicuous, white, slightly sunken, primary veins, the midrib no more prominent than the others; margins of mature leaves not hyaline or very narrowly so, ± glabrous to very shortly and coarsely cilolate with hairs (>60 along each margin), to c. 0.02 mm long. *Inflorescences* widely spreading to slightly pendulous; axis 2.1–3.4 mm long, 1(2)-flowered, the surface usually exposed in the central portion above a basal cluster of sterile bracts. *Fertile bract* depressed-ovate, 1.2–1.4 mm long, 1.3–1.5 mm wide. *Bracteoles* suborbicular to depressed-ovate 1.6–2.0 mm long, 1.8–2.1 mm wide, obtuse, obscurely mucronulate, the mucro to 0.1 mm long; abaxial surface glabrous, striate, pale green to straw-coloured, sometimes flushed pink towards the apex, becoming scarious towards the margins; adaxial surface glabrous; margins glabrous. *Sepals* ovate or narrowly ovate, 3.3–4.0 mm long, 1.8–2.0 mm wide, obtuse, obscurely mucronulate, the mucro <0.08 mm long; abaxial surface glabrous, straw-coloured, tinged pink towards the apex, ± striate with 7–9 veins, becoming scarious towards the margins; adaxial surface glabrous except for a small, obscure patch of hairs close to the base; margins glabrous. *Corolla tube* reddish pink, very narrowly campanulate, much exceeding the sepals, 6.5–7.5 mm long, 3.0–3.4 mm wide, internal surface with a ± continuous whorl of dense hairs in the lower half (1.7–2.0 mm above the base), the hairs 1.0–1.7 mm long and issuing from and between 5 short, irregular projections, a few hairs also scattered in the upper half of the tube. *Corolla lobes* pink, erect in the lower 2/3–3/4, recurved above, always shorter than the tube (ratio = 0.60–0.66:1), 4.0–4.5 mm long, 1.8–2.0 mm wide at base; the indumentum of the central portion of the internal surface, 0.7–1.0 mm long; glabrous tips c. 0.4 mm long. *Anthers* partially exserted from tube (by c. 7/8 of their length), 1.8–2.0 mm long, apex deeply emarginate. *Filaments* flat, 1.2–1.5 mm long, 0.5–0.6 mm wide, attached c. 2/3 above anther base, the apex bilobed above the point of anther attachment. *Nectary* annular, 0.5–0.6 mm long, shallowly and irregularly lobed. *Ovary* ovoid, 1.3–1.4 mm long, 0.9–1.0 mm wide. *Style* 8.5–10.0 mm long, shortly scabrous throughout. *Immature fruit* ellipsoid or broadly ellipsoid, much longer than the calyx, the surface with a shallow, irregular reticulum. (Figures 7, 8)

*Other specimens examined.* WESTERN AUSTRALIA: [localities withheld for conservation reasons] 5 Aug. 2010, A. Chant 1072 (CANB, PERTH); 13 Feb. 2007, G. Phelan & A. Chant 9 (PERTH).

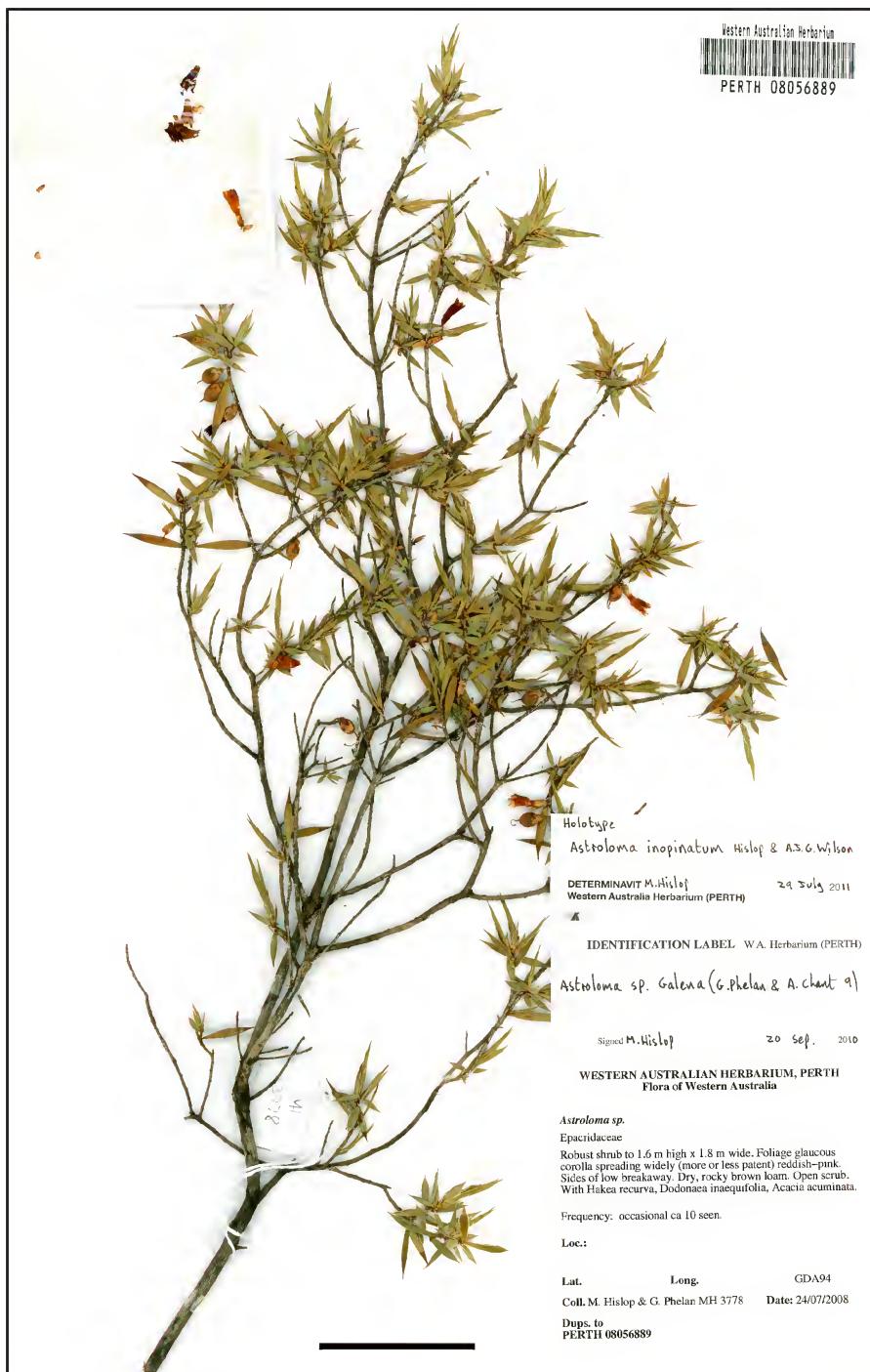


Figure 7. Scan of holotype of *Astroloma inopinatum* (PERTH 08056889). Scale = 5 cm.



Figure 8. *Astrolooma inopinatum*. Leaves and flower (unvouchered). Photograph by E.A. Brown.

*Distribution and habitat.* Known from a decomposed granite breakaway north of the Murchison River, east of Kalbarri National Park (Figure 3), growing in rocky, brown loam. The associated vegetation is open shrubland dominated by *Acacia acuminata*, *A. tetragonophylla*, *Hakea recurva*, *Dodonaea inaequifolia* and *Eremophila clarkei*.

*Phenology.* As with most early-flowering epacrids, especially those from the drier parts of south-western Australia, flowering is, in large part, governed by the rainfall pattern through the preceding summer–early autumn period. In the Kalbarri area rainfall is particularly variable during that time of year and flowering might be expected any time between March and July. Mature fruit is likely to be present for much of the second half of the year.

*Etymology.* The epithet is from the Latin *inopinatus* (unexpected), a reference to the atypically large growth habit for a member of this genus, and to the collection site, which represents an unusual habitat for members of the *Styphelioideae* generally in Western Australia.

*Conservation status.* Currently known only from a single, small population on an active pastoral lease. Listed by Smith (2012) as Priority One under DEC Conservation Codes for Western Australian Flora, under the phrase name *Astrolooma* sp. Galena (G. Phelan & A. Chant 9).

*Affinities.* The combination of large growth habit and glaucous, narrowly elliptic, concave leaves, together with the relatively small, spreading pink flowers make this a particularly distinctive species. Potential close allies within the genus are not apparent. *Astroloma glaucescens* Sond. bears some superficial resemblance, in that it also has narrow, glaucous leaves which lack the stout, marginal hairs characteristic of many members of the genus. However, it is readily separated by its much smaller stature, twisted, linear leaves and erect, orange-red flowers.

*Notes.* The above description of the flowers is based on limited material. The two fertile specimens examined are essentially in fruit, although the type does have a few flowers at or just post anthesis. The fruit are at various stages of development but some appear close to maturity. Because of the uncertainty measurements were not given in the formal description, but the largest fruits on *A. Chant* 1072 are 5–6 mm long by 4–5 mm wide.

*Astroloma inopinatum* is one of the largest species in the genus, reaching a height of at least 1.8 m.

***Astroloma oblongifolium* A.J.G.Wilson & Hislop, sp. nov.**

*A. pallido* affinis sed marginibus foliorum recurvis vel revolutis, marginibus sepalorum ciliatis differt.

*Typus:* South Eneabba Nature Reserve, Beros Road 1.8 km from Brand Highway, Western Australia, 11 April 2010, M. Hislop 3999 (*holo*: PERTH 08270988; *iso*: CANB, NSW, MEL).

*Astroloma* sp. Cataby (E.A.Griffin 1022), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed March 2012].

Open or straggling *shrubs*, sprawling to erect, to 30 cm high, resprouting after fire from a stout rootstock. Young *branchlets* with a dense indumentum of translucent white hairs *c.* 0.1 mm long, patent or reflexed up to 45°. *Leaves* crowded near branchlet apices, steeply antrorse to antrorse-appressed, narrowly oblong-elliptic to narrowly obovate, 5–18 mm long, 2–4 mm wide; apex long-mucronate, pungent, the mucro 0.5–1 mm long; base cuneate; petiole ± distinct, grading into lamina, greenish yellow, 0.5–1.5 mm long, glabrous or very sparsely hairy; lamina 0.30–0.45 mm thick, convex adaxially, longitudinal axis ± straight; surfaces discolored; adaxial surface dull grey-green, ± glaucous, glabrous or hairy with a sparse to moderately dense indumentum of variously orientated hairs to *c.* 0.3 mm long, venation not visible; abaxial surface paler, with sparse to moderately dense, minute, patent hairs to 0.05 mm long or sometimes glabrous, with 5–9 slightly raised primary veins and midrib no more prominent than the others; margins recurved to almost revolute, either eciliate or with sparse to dense, irregularly spaced cilia up to 0.5 mm long. *Inflorescences* erect; axis 2.0–3.5 (–6) mm long, single-flowered (one 2-flowered inflorescence seen), flattened portion of axis above the flower and bud-rudiment very reduced, usually completely concealed by subtending bracts. *Fertile bract* broadly to depressed-ovate, 1.6–2 mm long, 1.8–2.1 mm wide, subtended by 8–14 variously shaped, smaller sterile bracts. *Bracteoles* broadly ovate, 2.6–4.5 mm long, 2.5–3.5 mm wide, obtuse to subacute, mucronate, the mucro 0.3–0.4 mm long; abaxial surface cream-yellow in upper half, cream-green towards base, striate, variably hairy, ranging from sparse, appressed hairs in upper half to dense, patent hairs over entire surface or between the veins only; adaxial surface glabrous; margins scarious, ciliate. *Sepals* ovate to obovate, 5.5–10.5 mm long, 2.6–3.7 mm wide, subacute or acute, mucronate, the mucro to 0.5 mm long; abaxial surface hairy with a sparse to dense indumentum of ± erect hairs between the veins, pale yellow, conspicuously striate with 11–15 veins; adaxial surface glabrous except for a tuft

of sparse, appressed hairs near the base; margins scarious, ciliate throughout, or at least in the upper half, with hairs to c. 0.7 mm long. *Corolla tube* pale yellow throughout, cylindrical or very narrowly campanulate, from a little shorter than, to a little longer than the sepals, 6.0–9.5 mm long, 2.3–3.5 mm wide, internal surface with a ± continuous whorl of dense hairs in the lower half (1.5–2.0 mm above the base), the hairs 1.5–2.0 mm long, issuing from slightly thickened underlying tissue, glabrous above and then with hairs in the throat. *Corolla lobes* pale yellow, erect in the lower 2/3–3/4, recurved above, always shorter than the tube, although sometimes barely (ratio = 0.64–0.94:1), 4.5–8.0 mm long, 1.5–2.0 mm wide at base; the indumentum of the central portion of the internal surface 1–2 mm long; glabrous tips 0.5–1.5 mm long. *Anthers* exserted from the tube for most of their length, 1.8–2.8 mm long; apex emarginate. *Filaments* flat, 1.0–2.5 mm long, 0.5–1.0 mm wide, attached 1/2–3/4 above the anther base, the apex truncate to bilobed above the point of anther attachment. *Nectary* annular, 0.50–0.75 mm deep, margin entire or lobed for up to 1/2 of length. *Ovary* ovoid to ellipsoid, bluntly 5-angled, 0.9–1.5(–2.0) mm long, 0.8–1.4 mm wide. *Style* 8.5–12 mm long, minutely scabrous in upper half. *Fruit* ellipsoid, c. 5.5–6.5 mm long and 3–4 mm wide (but refer comment under notes below), slightly longer than the calyx, the surface with a shallow, irregular reticulum. (Figure 9)

*Other specimens examined.* site 2, 11.5 km S of Cachionalgo Hill, off Bindoon–Dewars Pool Rd, 7 Nov. 1996, M.G. Allen 194 (PERTH); site 4, off Trig Rd – (E of), 22 km SSE of Bindoon, 18 Nov. 1996, M.G. Allen 1164 (PERTH); 8 miles [c. 12.9 km] W of Calingiri, 24 Apr. 1959, T.E.H. Aplin 455 (PERTH); Mt Lesueur, near trig on summit; Mount Lesueur National Park, 1 Oct. 1997, E.A. Brown & G. Taaffe 97/149 (NSW, PERTH); 5 km SSW of Ironstone Knoll [Coomallo Nature Reserve], 21 June 1996, R. Davis 1414 (PERTH); 17 miles N of Regans Ford, 3 miles E of main road, 18 Feb. 1970, A.S. George 9820 (NSW, PERTH); off Jurien Rd, near Mt Benia, E of Jurien, 2 June 1978, E.A. Griffin 1022 (PERTH); proposed Mount Lesueur Reserve, S of Mt Peron, 21 May 1981, E.A. Griffin 3150 (PERTH); Hi Vallee property (D. & J. Williams) Warradarge, near intersection of track and boundary fenceline along NE boundary of main bush block, 1 May 2000, M. Hislop 2005 (PERTH); Coomallo Nature Reserve, S boundary fire break, 1.1 km SW of Brand Hwy, 11 Aug. 2009, M. Hislop 3909 (CANB, PERTH); Badgingarra National Park, c. 500 m along walk trail W of Brand Hwy, W of Badgingarra township, 11 Apr. 2010, M. Hislop 3997 (PERTH); near Bindoon, 50 miles [c. 80 km] NE of Perth, in the ranges, 16 Aug. 1964, D. Lewis 9 (NSW); 7 miles [c. 11.3 km] from Bindoon, 50 miles [c. 80 km] NE of Perth, 27 Apr. 1957, H.C. Lewis 34 (CANB, K, PERTH); 10 km S of hotel at New Norcia, E side of road, 13 May 1991, S. Patrick 545 (PERTH); 50 m W of NE corner of Nature Reserve 27595, at NE corner of Bindoon Army Training Area, 5 June 1991, S. Patrick 547 (PERTH); Reserve 28184 C6, 1.5 km E of parking bay, NW corner Bindoon Army Training Area, S side of road and for c. 100 m into reserve from road, 27 June 1991, S. Patrick 553 (PERTH); track to Mt Lesueur, 11 July 1982, J.M. Powell 1762 (K, NSW, PERTH); Old Plains Rd, 8.3 km [S] from Calingiri Rd, 4 July 2010, C. Puente-Lelievre & E.A. Brown CPL 39 (NSW, PERTH); S of New Norcia, Nature Reserve on W side of Great Northern Hwy, 25 May 1989, A.J.G. Wilson 193, 194 (PERTH); NW corner of Bindoon Army Training Area NE of Bindoon town, 25 May 1989, A.J.G. Wilson 197 (PERTH); Eneabba CRA mine site, 23 June 1989, A.J.G. Wilson s.n. (PERTH).

*Distribution and habitat.* Found from Eneabba south to the Julimar State Forest, SSE of Bindoon (Figure 3). Grows in sandy soils over laterite, in open heath in the north of its range to woodlands dominated by *Eucalyptus wandoo* or *Corymbia calophylla* in the south.

*Phenology.* The main flowering period is May, although flowers have been recorded from February to July. Little fruiting material has been collected but mature drupes should be present about two months after flowering.

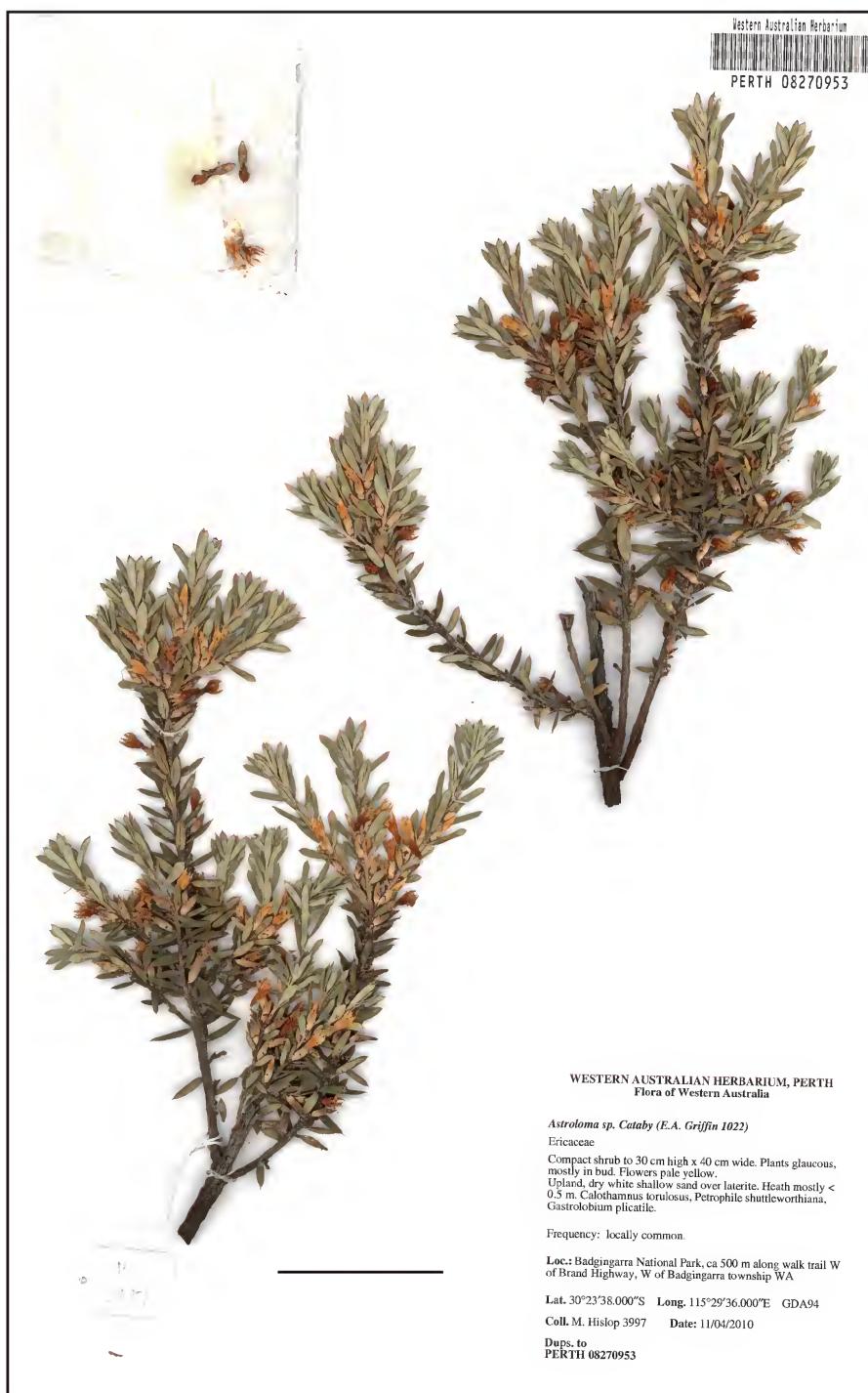


Figure 9. Scan of *Astroloma oblongifolium* (PERTH 08270953). Scale = 5 cm.

*Etymology.* The name refers to the apparent oblong shape of the leaves, which is accentuated by the recurved to revolute margins.

*Conservation status.* This species was previously assigned a Priority Four DEC Conservation Code. However, as a result of extensive survey in the last 20 years, it is now known to have a wide distribution and range of habitats, including in many Nature Reserves and National Parks. Therefore it is no longer considered of conservation significance.

*Affinities.* Most collections of this species have been previously assigned to *A. pallidum*, on the basis of a similar flower colour and growth habit. *Astroloma oblongifolium* differs primarily from *A. pallidum* in having recurved or revolute rather than adaxially concave leaves. And whereas the sepal margins of the new species are manifestly ciliate, those of *A. pallidum* are essentially glabrous — occasionally a few short hairs may be present about the base of the mucro. *Astroloma oblongifolium* and *A. pallidum* can be found in the same habitats across all but the northernmost part of the range of *A. oblongifolium*, but no apparent hybrids have been found. The peak flowering times for the two species differ, with *A. oblongifolium* flowering mainly in autumn and early winter, and *A. pallidum* mainly in late spring.

*Notes.* The description of the fruit given in the text above is based on a single collection and therefore cannot be regarded as definitive.

This species has a disjunct distribution with a southern population node in the northern Darling Range and a northern node closer to the coast on the Geraldton Sandplains. Plants from these two areas exhibit some differences, at least in their foliar morphology. Relative to those from the southern populations, plants from the Geraldton Sandplains (the type form) have generally hairier leaves (both surfaces being moderately to densely hairy) which are more abruptly contracted below the apical mucro. Some collections from the Mount Lesueur area however differ in this regard in having more or less glabrous leaves. The southern variant of the species is rather poorly known, most collections being either sterile or with only one or two old flowers present. In addition, only one fruiting collection of the species (this of the type form) has been made. This limits our capacity, at this stage, to fully assess other potential differences between the two forms.

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**A revision of the Australian species of *Eclipta* (Asteraceae: Ecliptinae),  
with discussion of extra-Australian taxa****Anthony E. Orchard<sup>1</sup> and Edward W. Cross<sup>†</sup>**

<sup>1</sup>c/o Australian Biological Resources Study, GPO Box 787, Canberra, Australian Capital Territory 2601  
Email: tony.orchard@environment.gov.au

**Abstract**

Orchard, A.E. & Cross, E.W. A revision of the Australian species of *Eclipta* (Asteraceae: Ecliptinae), with discussion of extra-Australian taxa. *Nuytsia* 23: 43–62 (2013). The genus *Eclipta* L., of six species, is native to South America and Australia, with one species, *E. prostrata* (L.) L., a pantropical and warm temperate weed. The number of taxa currently recognised in the genus is discussed. The Australian taxa, comprising three species and two subspecies (*E. prostrata*, *E. alatocarpa* Melville and *E. platyglossa* F.Muell. subsp. *platyglossa* and subsp. *borealis* E.W.Cross & Orchard, subsp. nov.) have been studied morphologically across their full range. A lectotype is chosen for *E. platyglossa*. All Australian taxa are keyed, described, illustrated and mapped, and extra-Australian taxa are keyed and described, and most illustrated.

**Introduction**

In 2004 the late Ed Cross commenced a revision of the Heliantheae Cass. alliance and the Eupatoreiae Cass. for *Flora of Australia*, beginning with Heliantheae subtribe Ecliptinae Less., especially the genera *Eclipta* L., *Wedelia* Jacq. and *Pentalepis* F.Muell. He had made good progress with several parts of this study, until his tragically early death in 2007 left the study incomplete. The present senior author was engaged by the Australian Biological Resources Study (ABRS) in 2010 to edit and complete the *Flora* manuscripts. This paper presents the results of that revision, in respect to the genus *Eclipta*. The taxa recognised are essentially those drafted by Cross, although the senior author has modified the circumscription of the subspecies of *E. platyglossa* F.Muell. somewhat, and examined and discussed overseas material to put the Australian species in context.

**Size of the genus *Eclipta***

The genus *Eclipta* was described by Linnaeus (1771: 159), with three species (1771: 286), *E. erecta* L. (based on *Verbesina alba* L.), *E. prostrata* L. (based on *Verbesina prostrata* L.) and *E. punctata* L. (based on *Bellis ramosa* Jacq.). As the name *Verbesina alba* was cited in the synonymy of *E. erecta*, the latter name is illegitimate. The legitimate name for this entity is *E. alba* (L.) Hassk. Similarly, as the name *Bellis ramosa* Jacq. was cited in the synonymy of *E. punctata*, *E. punctata* is illegitimate as well. Subsequently Roxburgh (1832) united *E. alba* and *E. prostrata* under the latter name. He also suggested that *E. punctata* was conspecific, although not formally including it in synonymy.

In the following 180 years many other names (both new names and recombinations) have been proposed in *Eclipta*, the overwhelming majority being later shown to be local variants of *E. prostrata*, which is now known as a pantropical and warm temperate weed. This species, as *E. erecta* L., nom. illeg. (*Verbesina alba* L.; *E. alba* (L.) Hassk.) is also the conserved type of the genus. A very few additional taxa are still accepted as distinct species, although in the absence of a global monograph, the status of some is problematical. The consensus in works over the last century (Reiche & Philippi 1903; Arechavaleta 1906; Cabrera 1963; Aristeguieta 1964; D'Arcy 1975; Nash 1976; Jessop 1981; Hilliard 1977; Cooke 1986; Stanley 1986; Murray 1992; Lawrence 1992; Jeanes 1999; Robinson 2006; Strother 2006; Panero 2007; Hu 2009) has been that the genus comprises three, four or five species, although some claim perhaps only one (Wagner *et al.* 1999), others six or more (Dunlop 2000) or even up to 15 (Smith 1991).

In the only recent conspectus of the genus as a whole (*Global Compositae Checklist* (GCC), Flann 2009–) ten species of *Eclipta* were listed as being accepted. This seems an overestimate. A total of six is adopted here. The species recognised in the *Global Compositae Checklist*, their reported distribution, and other opinions on their acceptance, are as follows:

### ***Eclipta alatocarpa* Melville**

Endemic to Australia (GCC).

*Status.* Accepted in the current paper.

### ***Eclipta brachypoda* Michx.**

Recorded from Bolivia by GCC. However, the same work lists it as an illegitimate name (*Amellus caroliniana* Walter cited as synonym). The taxon was subsequently legitimately described as *Eclipta erecta* var. *brachypoda* Torr. & A. Gray. GCC notes that three recent works consider it synonymous with *E. prostrata*.

*Status.* Not accepted in the current paper.

### ***Eclipta elliptica* DC.**

Recorded for Brazil, Uruguay, Paraguay, Argentina and Chile by GCC. It is accepted for Uruguay (Arechavaleta 1906), Chile (Reiche & Philippi 1903) and Argentina (Zuloaga & Morrone 1999, who also list it for Brazil and Uruguay). There is a description and illustration in Arechevaleta (1906: 319). It is included in *Lista de Espécies Flora do Brasil 2010* (<http://floradobrasil.jbrj.gov.br/2010/>, accessed 5 December 2011) as native but not endemic to Brazil. Blake (1930) listed *E. elliptica* DC. as a synonym of *E. bellidoides* (Spreng.) Schultz-Bip., but this seems to be an error. *Eclipta elliptica* is a plant with elliptical leaves and small white ligules (see above). *Eclipta bellidoides* (based on *Jaegeria bellidoides* Spreng.) is a quite different plant, with yellow ray corollas, and is now considered synonymous with *Jaegeria hirta* (Lag.) Less. (Zuloaga *et al.* 2008; N. Hind pers. comm.). Blake also listed *Wollastonia prostrata* DC. as a synonym of *E. bellidoides*, but the type of this name (Brazil, Prov. Rio Grande, C. Gaudichaud s.n., 1833 (Herbier Imperial du Bresil 1073), P 710030 (photo!)) matches *E. elliptica*, not *J. hirta*. Zuloaga *et al.* (2008) place *Wollastonia prostrata* DC. as a synonym of *E. elliptica*.

*Status.* Accepted in the current paper.

***Eclipta leiocarpa* Cuatrec.**

Recorded from Colombia by GCC, on the basis of its original description, and inclusion in the unpublished Govaerts World Compositae Checklist A-G held at K. The holotype (F 49427F) and isotype (COL 4912) specimens are available for viewing on JSTOR. I have seen no other material. The plant is described as an hygrophilous herb; leaves lanceolate (some almost narrowly ovate), attenuate at base, 10 cm long, 3.5 cm wide, coarsely serrate; involucre of broadly ovate to ovate-oblong bracts which are prominently 9-nerved; achenes grey, oblong, quadrangular and moderately compressed, shortly ciliate at apex, otherwise glabrous and smooth. In these characters *E. leiocarpa* differs from other South American (and Australian) species. Acceptance of the name *E. leiocarpa* other than in the protologue description has not been traced. The type material might represent immature *E. prostrata*, but seems distinct in a number of respects.

*Status.* Accepted in the current paper.

***Eclipta megapotamica* (Spreng.) Sch.Bip. ex S.F.Blake**

Recorded from Brazil, Uruguay, Paraguay, Argentina and Chile by GCC, on the basis of inclusion in the unpublished Govaerts World Compositae Checklist A-G held at K. This species is perennial, with lanceolate leaves 5–6 cm long, entire, and achenes which are winged, compressed, c. 5 mm long, with relatively long awns (c. 1 mm). The wings of the achenes are not fused into a cup at the apex (castellated), as in *E. alatocarpa*, and are narrower, and the achene body is almost smooth, not moderately warty as in *E. alatocarpa*. It is described and illustrated in Cabrera (1963: 200, 203, Figure 57A–C), where it is recorded from Brazil, Uruguay and northeastern Argentina near the River Plate. It is listed in Zuloaga *et al.* (2008) as native to Argentina, Brazil and Uruguay, and in *Lista de Espécies Flora do Brasil 2010* (<http://floradobrasil.jbrj.gov.br/2010/>, accessed 5 December 2011) as native but not endemic to Brazil (*fide* C.A. Mondin).

*Status.* Accepted in the current paper.

***Eclipta paludicola* Steud.**

The name *E. paludicola* Steud., described as an annual species from Brazil, was based on ‘*E. palustris* Arrab.’ [D. Francisco Antonio de Arrábida, 1771–1850]. No publication by Arrábida including this name has been traced, suggesting that this was just a manuscript name. *Eclipta paludicola* is recorded from southern Brazil according to GCC, but is not included in *Lista de Espécies Flora do Brasil 2010* (<http://floradobrasil.jbrj.gov.br/2010/>, accessed 5 December 2011), nor in Zuloaga *et al.* (2008). Material housed under this name in P (Antigua, L.A. Richard s.n., P 2534355 & 2534353 (ex Herb. Cosson); Guadeloupe, L.A. Richard s.n., P 2534354; Sta Cruz, L.A. Richard s.n., P 2534356) all seems to be *E. prostrata*.

*Status.* Not accepted in the current paper.

***Eclipta platyglossa* F.Muell.**

Endemic to Australia (GCC).

*Status.* Accepted in the current paper.

### **Eclipta prostrata (L.) L.**

Widespread in tropical and warm temperate regions, including Australia (GCC).

*Status.* Accepted in the current paper.

### **Eclipta punctata Jacq. / Eclipta punctata L.**

The name *E. punctata* L. (Mant. Pl. 286 (1771)) was based on *Bellis ramosa* Jacq., Enum. Syst. Pl. 28 (1760) (cited by Linnaeus as ‘Jacq. amer. 216, t. 129’ – see TL-2 for discussion of the relationship between Jacquin’s *Enum. Syst. Pl.* (1760) and *Select. Stirp. Amer. Hist.* (1763)). The name *E. punctata* L. is thus illegitimate. GCC cited ‘*Eclipta punctata* Jacq. *Select. Stirp. Amer. Hist.* 216, t. 129 (1763)’ as an accepted name. This combination is not made in the text nor on the plate as cited, and the combination seems not to have been made by this author. Jacquin’s species (*B. ramosa*) came from ‘Domingo and Martinica’ (San Domingo and Martinique), and was originally described skeletally as ‘*Bellis ramosa caule ramoso. ♂ [=annual]*’. It appears from the plate to be *E. prostrata*.

*Status.* Not accepted in the current paper.

### **Eclipta pusilla M.E.Jones**

Recorded from north-western Mexico by GCC, on the basis of inclusion in the unpublished Govaerts World Compositae Checklist A-G held at K. This is an illegitimate later homonym of *E. pusilla* (Poir.) DC. (*Verbesina pusilla* Poir.), a plant from Puerto Rico, accepted by Candolle with doubt as to its identity. A specimen in P (Porto Rico, no collector or date, (P 2534334 photo!)), annotated as *V. pusilla* Poir. and *E. pusilla* DC. (?type material), is *Spilanthes iodescaea* A.H.Moore (det. Blake, 1925). A second sheet (P 2534333 photo!) is a probable duplicate. *Eclipta pusilla* M.E.Jones was described from Mexico, ‘Arroyo Undo, Baja California Norte’. McVaugh (1984) recognised only *E. prostrata* from western Mexico, and stated that this was the only species of *Eclipta* in North America. The description of *E. pusilla* M.E.Jones in any case seems unlikely to be that of an *Eclipta* (‘Involucle a single piece but 5-toothed and with hyaline edges lacerate...Disk flowers large and embraced by the hyaline and hooded bracts which are...hooded and lacerate at the tip...Disk akenes not developed but ray akenes dominating the heads...’).

*Status.* Not accepted in the current paper.

### **Materials and methods**

This revision is based on a morphological study of the holdings of the following herbaria: AD, BRI, CANB, DNA, HO, MEL, NE, NSW, NT and PERTH. Loans from most of these herbaria (excluding NSW) were obtained in 2003 and 2004. A supplementary loan of recent collections (including duplicates from other herbaria) was obtained from DNA in late 2011. Some NSW material has been studied during visits to that herbarium in 2010 and 2011. The senior author visited K and G in 2012 and examined extra material there. All illustrations were produced by the senior author, using a camera lucida to establish proportions and sizes. Material cited below as photo! from various herbaria was seen as online photographs only, either from the herbaria themselves or via JSTOR Plant Science.

### Taxonomic treatment of the Australian taxa

***Eclipta*** L., *Mant. Pl.* 157 (1771).

*Ecliptica* Kuntze, *Revis. Gen. Pl.* 1: 334 (1891), *orth. var.*

*Type:* *E. erecta* L., *nom. illeg.* [ $\equiv$  *E. alba* (L.) Hassk., = *E. prostrata* (L.) L.], *typ. cons.*

Annual or perennial *herbs*; *stems* usually weak, procumbent, annual. *Leaves* simple, opposite, linear to lanceolate or elliptic, 3-veined (sometimes obscurely), sessile to shortly petiolate, base round to attenuate, entire to minutely toothed, pilose, with 2-celled hairs seated on a cluster of tiny epidermal cells. *Capitula* solitary or in dichasial clusters in the upper leaf axils, radiate; *involucral bracts* in 2 series,  $\pm$ equal, herbaceous; *receptacle* paleaceous; *paleae* very narrowly linear, keeled, sparsely pilose, sometimes absent from central florets. *Ray florets* in several series, pistillate or sterile; ligules narrow, usually 2-lobed, white or yellow; *disc florets* bisexual, fertile, with corolla 4-lobed. Immature *achenes* smooth; mature achenes slightly dimorphic, oblong, tuberculate, ray achenes  $\pm$ 3-angled, others 4-angled, angles sometimes thickened and cartilaginous, or winged; *pappus* a membranous cup, sometimes produced into 2–4 short, weak awns, rarely absent.

*Eclipta* species are characterised by being usually perennial herbs (persistent woody rootstock, weak, slender, annual stems), found in damp or boggy situations, often on stream and lake sides, and then facultatively semiaquatic, sending submerged stems out into free water, with vertical emergent flowering branches. The stems root adventitiously when in contact with soil or when submerged. The capitula are small, with involucral bracts lanceolate to ovate, herbaceous, in two series, and are solitary in the axils of the upper leaves (sometimes nodding), or borne in open dichasium on long peduncles. Paleae are present, at least among the outer florets, and are linear (almost filiform), pilose and persistent. The ray florets are usually in several series and can be numerous (50 or more), usually with relatively small and narrow ligules which are two-lobed, white or yellow. Disc florets are also numerous, but often fewer than the ray florets. The pappus on both kinds of florets is a short, membranous cup, sometimes weakly serrate, and sometimes produced into two to four short, often soft, teeth or awns. Achenes are cylindrical to compressed, two- to four-angled, usually rugose to tuberculate (rarely smooth), the lateral angles sometimes thickened and cartilaginous, or winged.

*Distribution.* A genus of six species, with a trans-Pacific distribution. Three species are native to South America, and two others to Australia. A sixth species, *E. prostrata*, is thought to be native to central and southern South America, but is now widespread as a weed in tropical and warm temperate regions worldwide. Why this species of *Eclipta*, and not others, has become weedy, is not clear. All have similar general morphology, lifeforms and habitat requirements. The weediness of *E. prostrata* may perhaps be linked to its copious production of seed. Capitula of *E. prostrata* usually contain up to 100 achenes, sometimes twice that number. Other species usually have capitula of about 30 achenes.

*Relationships.* Panero *et al.* (1999), in a molecular study based on chloroplast DNA restriction site data, found *Eclipta* to be basal to what they termed the wedeloid group, containing most of the genera with variously winged achenes and a pappus of persistent or caducous bristles arising from a short terminal crown. This group has its greatest diversity in the Neotropics, but with a few Australian native species and genera, including taxa of *Eclipta*, *Wollastonia*, *Pentalepis* and *Wedelia s. lat.* However, generic limits in this group are still fluid, Panero *et al.* (1999) observing that the wedeloid group is the least understood and most problematic of the Heliantheae. No phylogenetic studies have been carried out within *Eclipta*. On morphological grounds the South American (including *E. prostrata*) and Australian

taxa fall into two groups correlated with geography. The three endemic South American species have involucral bracts which are gradually rounded at the base while these bracts are pouched in the two Australian native species. *Eclipta elliptica* and *E. megapotamica* have relatively long pappus awns (but see note under *E. alatocarpa*, and note that the awns in *E. elliptica* are sometimes absent), while the Australian species and *E. prostrata* have short or no awns. On the other hand, the Australian *E. alatocarpa* shares its winged achenes with the South American *E. megapotamica*. *Eclipta prostrata* is somewhat intermediate between the winged- and unwinged-achene species in having achenes which are strongly flattened, with thickened cartilaginous lateral angles.

*Etymology.* From the Greek, *ekleipo* (to lack) as some species are without a pappus or achene wings.

### Key to the Australian species of *Eclipta*

- 1. Achenes with broad, erose wings ..... **1. *E. alatocarpa***
- 1: Achenes wingless, with or without thickened cartilaginous margins
- 2. Ligules yellow; ray florets 8–12; upper leaves abruptly contracted basally; involucral bracts pouched basally ..... **2. *E. platyglossa***
- 2: Ligules white; ray florets numerous; upper leaves gradually tapered to base; involucral bracts rounded basally, not pouched ..... **3. *E. prostrata***

**1. *Eclipta alatocarpa*** Melville, *Trans. & Proc. Roy. Soc. S. Australia* 83: 77 (1960). *Type citation:* ‘South Australia: Arkaringa Ck., 12 miles [c. 19 km] N of Mt Barry Stn, 60 miles [c. 95 km] S of Oodnadatta’, E.H. Ising 3766, Aug. 30, 1955’ (*holo*: K 9768!; *iso*: AD *n.v.* CANB 318615!, K 9767! (and spirit collection K 31426.000), MEL 2196379!).

*Illustrations.* R. Melville, *Trans. & Proc. Roy. Soc. S. Australia* 83: 78 (1960); D.A. Cooke in J.P. Jessop & H.R. Toelken, *Fl. S. Australia* 4<sup>th</sup> edn, 3: 1435, Figure 644A (1986).

Decumbent annual *herb* (10–)30–40 cm tall; *stems* weak, scabrous to subglabrous. *Leaves* subsessile, distant, lanceolate, (15–)25–50 mm long, 5–12(–14) mm wide, entire or with few irregular tiny teeth, attenuate at the base, scabrous; hairs 0.4–0.5 mm long, semiappressed, with lower cell swollen. *Peduncles* 5–15 mm long. *Involucral bracts* 8–10, ovate, lanceolate or elliptic, striate, 5–6 mm long, scabrous. *Ray florets* 9–11; ligules yellow, obovate, c. 2 mm long. *Disc florets* 20–25, yellow. *Achenes* 4–6 mm long, 5–6 mm wide, obovate, papillose or rugose when mature; *ray achenes* with 3 flat erose wings fused apically into a castellated cup; *pappus* of several connate scales to 1 mm long, with 1 or 2 extended as short, soft spines; *disc achenes* similar but with 2 erose wings. (Figure 1)

*Selected specimens (13 examined).* NORTHERN TERRITORY: 15 miles [c. 21 km] E Lorne Creek, 15 July 1959, G. Chippendale 6405 (AD, BRI, MEL); Tobermory, 22 May 1972, C. Dunlop 2562 (AD, CANB, K, MEL); Andado Stn, 14 Apr. 1977, P.K. Latz 6781 (AD, CANB, DNA, MEL). SOUTH AUSTRALIA: near Eringa, 16 July 1997, R. Bates 47081 (AD [& BR, BRI, CANB, MEL, NT, RSA, S, all *n.v.*]); Algebuckina Waterhole, 9 Mar. 1984, N.N. Donner 9937 (AD); Gidi Giddinna Creek, 46 km NE Coober Pedy, 30 Apr. 1997, D.E. Symon 15668 (AD); Coober Pedy–Oodnadatta Rd, at the crossing of the Algebullculla Creek, 30 June 2000, D.E. Symon 16210 & J. Symon (AD); Peake Creek, between William Creek and Oodnadatta, 10 Mar. 1983, J.Z. Weber 8922 (AD). QUEENSLAND: S. Oestrus, Gilruth Plains, 7 Mar. 1949, K.C. Baker G830 (CANB, K); 80 km SE of Waterloo HS, 28 June 1989, A.J. Emmott 266 (AD, BRI, K); Currawinya National Park, Paroo River floodplain S of Caiwarra ruins, 20 Mar. 1997, P.I. Forster 20511 & M. Watson (BRI, MEL).

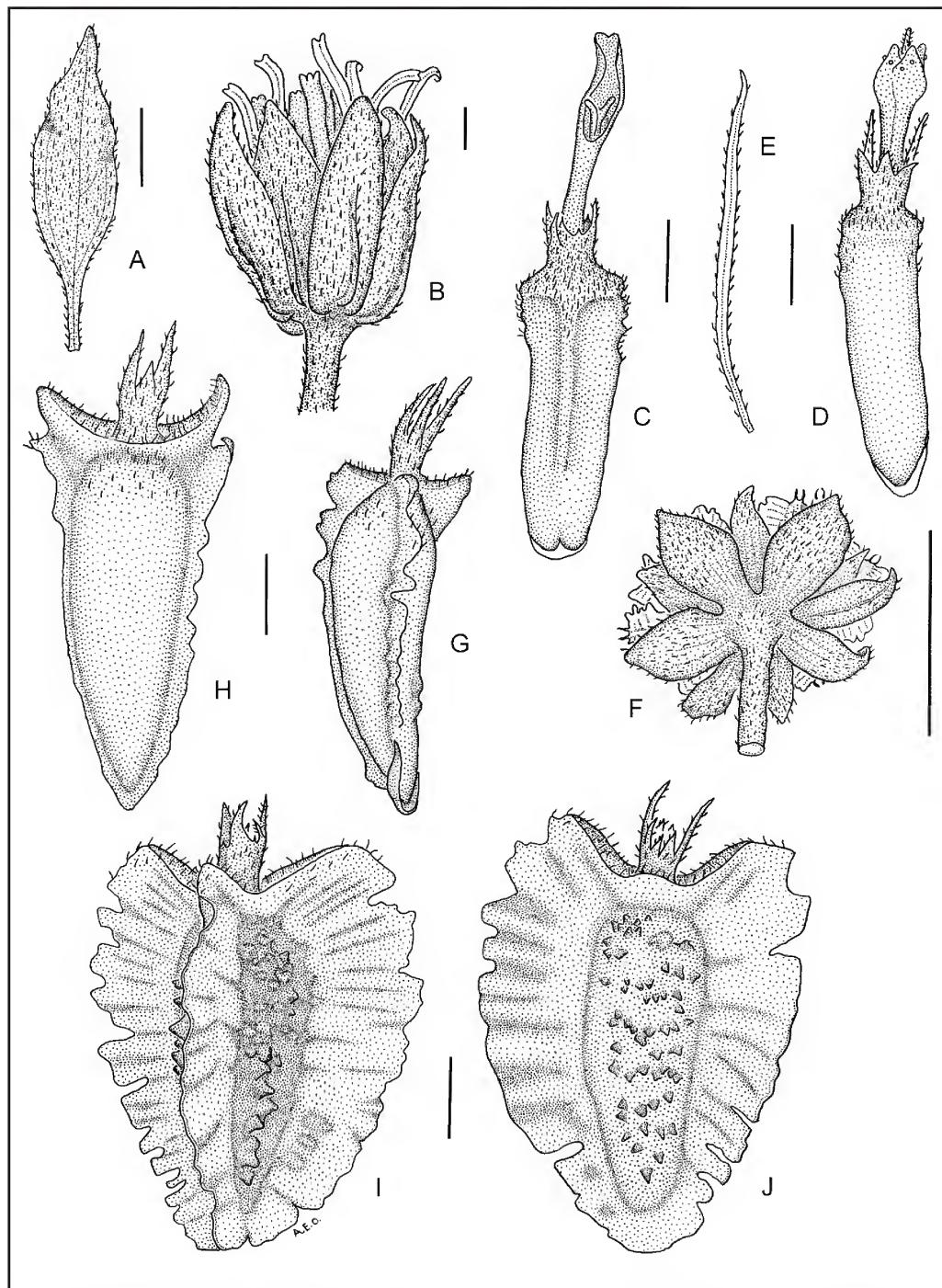


Figure 1. *Eclipta alatocarpa*. A – leaf; B – capitulum in flower; C – ray floret; D – disc floret; E – palea; F – capitulum in fruit, viewed from below; G – immature ray achene; H – immature disc achene; I – mature ray achene; J – mature disc achene. All based on D.E. Symon 15668, AD. Scale bars: A, F = 1 cm; B-E, G-J = 1 mm. © ABRS, reproduced with permission.

**Distribution and habitat.** Endemic to inland Australia and restricted to scattered localities in South Australia, the Northern Territory and Queensland (but probably often overlooked) (Figure 2A). Grows in heavy soils (black cracking soils, clays, alluvium) in damp areas or locations subject to intermittent flooding, streamsides and floodplains.

**Flowering and fruiting period.** Flowers and fruits recorded March–August.

**Conservation status.** Widespread in inland localities, including at least two National Parks, but rarely collected, possibly overlooked. Equivalent to IUCN (2001) Data Deficient.

**Etymology.** From the Latin *alatus* (winged) and the Greek *carpos* (fruit), referring to the winged achene.

**Typification.** There are two type sheets of this species in K, one (K 9768) labelled holotype, the other (K 9767) labelled isotype (plus some flowers in spirit, K 31426.000). Normally, one of these sheets would be chosen as the lectotype. This is not necessary in this case. K 9768 bears only a handwritten label, and must be the material on which Melville based his description. It is thus correctly labelled holotype. K 9767, in addition to a handwritten label in Ising's hand, bears a typed label prepared in AD, in which the material is described as an isotype, and a reference to Melville's publication is included. As this must have been prepared post-publication, the material was not available to Melville, and is thus correctly labelled as an isotype.

**Affinities.** This is the only annual species of *Eclipta* in Australia. The winged achenes of *E. alatocarpa* are shared with *E. megapotamica* of South America, but the wings in the latter are narrower, not fused apically into a cup, the body of the achene in *E. megapotamica* is smooth, and the ‘awns’ are longer. It should be noted that the awns in these two species are anatomically different, and analogous not homologous. The awns in *E. alatocarpa* (and all other species of *Eclipta*) are anatomically elongated scales, and thus true pappus awns, albeit weak. Those in *E. megapotamica* are extensions of the wing apices, arising from the body of the achene, the true pappus consisting of a ring of tiny scales.

**Notes.** The illustration of ‘*Eclipta alatocarpa*’ in the *Flora of Central Australia* (Jessop 1981: 381) is *E. prostrata*.

**2. *Eclipta platyglossa* F.Muell., *Fragm.* 2: 135 (1861).** *Type citation:* ‘Per amplos Novae Hollandiae extratropicae tractus; sic ad flumina Yarra Yarra, Avoca, Murray, Darling, ad sinus littorales St. Vincent’s Gulf et Moreton Bay, alibique’ (*lectotype*, designated here: Avoca, Dec. [18]53, Dr. M[üller] s.n., MEL 2217443; *residual syns*: River Darling, *s. dat.*, *Dallachy & Goodwin* s.n., MEL 2217447; St Vincent’s Gulf, *s. dat.*, [F. Mueller s.n.], MEL 2217449; Moreton Bay, *s. dat.*, [F. Mueller s.n.], MEL 2217446; Murray River, *s. dat.*, *D[allachy]* s.n., MEL 2217441).

*Wollastonia ecliptoides* F.Muell., *Pl. Victoria Lithograms*, legend to t. 39 (1865), *nom. illeg.*, *nom. superfl.*

*Wedelia ecliptoides* F.Muell., *Pl. Victoria Lithograms*, legend to t. 39 (1865), *nom. inval.*, *pro syn.*

*Eclipta erecta* auct. non L.: O.W. Sonder, *Linnaea* 25: 482 (1852), based on specimen [S.A.]: ‘in umbrosis ad ripam fl. Torrens’, Jan., *Herb. F. Mueller* s.n. (specimen not located).

Prostrate or ascending slender perennial *herb* (5–)20–30 cm tall, *stems* with short appressed hairs, prostrate, rooting at nodes. *Leaves* subsessile, distant, narrowly lanceolate to linear, 15–50(–80) mm long, 2–7 mm wide, ±entire or with few tiny scattered teeth, abruptly contracted at the base, surfaces appressed-pilose; hairs 0.3–0.8 mm long, appressed or semierect, lower cell swollen or not. *Peduncles* 5–40 mm long. *Involucral bracts* 8–10, lanceolate, sparsely hairy, weakly striate, 3–4 mm long, pilose, pouched at base. *Ray florets* 8–12; ligules yellow, oblong. *Disc florets* 8–15, yellow. *Achenes* 2–3 mm long, 1 mm wide, cylindrical, yellow-brown to purple-black, densely rugose when mature; ray achenes ±3-angled, disc achenes ±4-angled, otherwise similar; *pappus* absent or a minute cup with irregularly ciliolate margins.

*Distribution.* An endemic Australian species, of which two subspecies can be distinguished, one mainly southern temperate to subtropical, the other northern tropical.

*Common names.* Yellow Twin Heads, Yellow Eclipta.

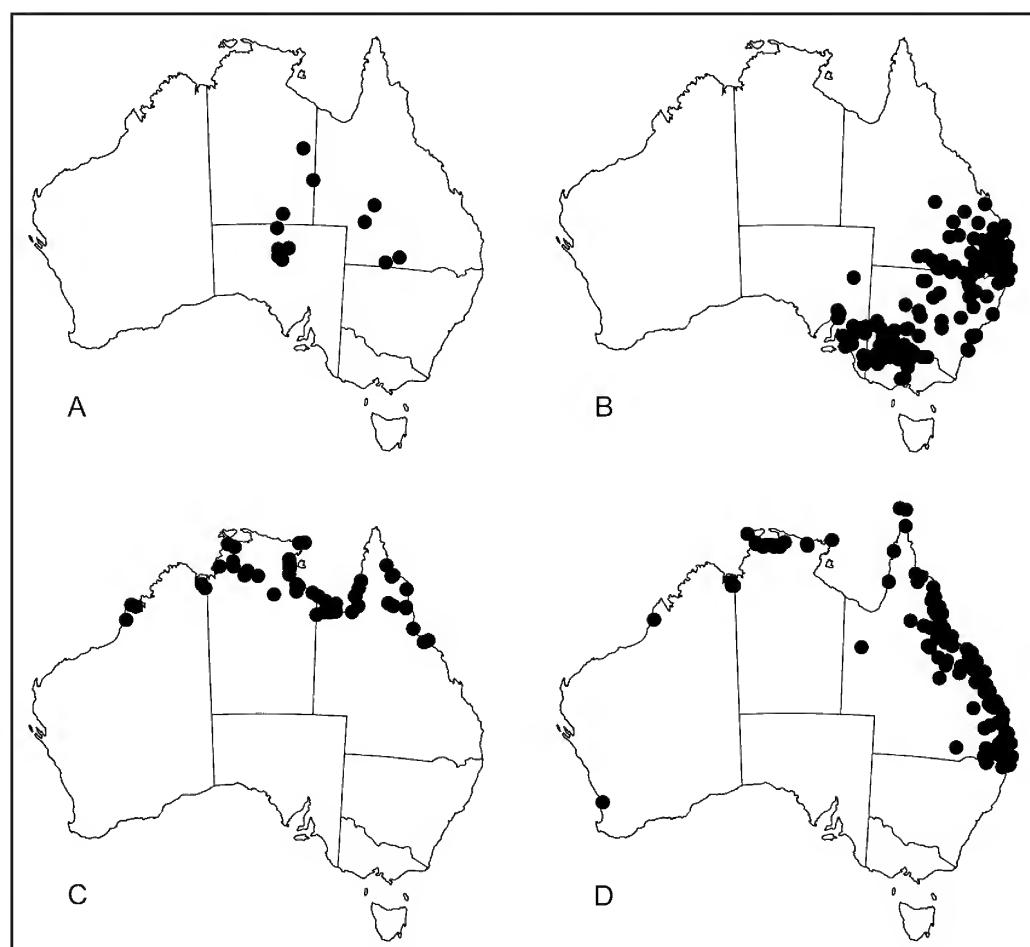


Figure 2. Distribution of the various *Eclipta* taxa in Australia. A – *E. alatocarpa*; B – *E. platyglossa* subsp. *platyglossa*; C – *E. platyglossa* subsp. *borealis*; D – *E. prostrata*.

*Affinities.* This species differs from the introduced *E. prostrata* in lacking cartilaginous thickened margins on the achene, in having leaves which are abruptly contracted at the base, in its yellow florets, and in having capitula with c. 20–30 florets (rather than c. 50 up to 200). The paleae in *E. platyglossa* are found mainly subtending the outer florets, absent from the central ones, while in *E. prostrata* most florets have a palea. In addition, the involucral bracts in *E. prostrata* are gently curved at the base, while those of *E. platyglossa* are distinctly pouched.

### Key to subspecies of *Eclipta platyglossa*

Two subspecies are recognised.

1. Leaves appressed-pilose; hairs soft, fine throughout; ligules c. 1 mm long; hairs on involucral bracts sparse, mainly marginal ..... **2a. *E. platyglossa* subsp. *platyglossa***
- 1: Leaves semierect-pilose; hairs stiff, with swollen basal cell; ligules c. 2 mm long; hairs on involucral bracts moderately dense, dorsal and marginal ..... **2b. *E. platyglossa* subsp. *borealis***

#### **2a. *Eclipta platyglossa* subsp. *platyglossa***

*Illustrations.* F. Mueller, *Pl. Victoria Lithograms*, t. 39 (1865); G.M. Cunningham, W.E. Mulham, P.L. Milthorpe & J.H. Leigh, *Pl. W. New South Wales* 666 (1981).

*Leaves and stems* appressed-pilose, the hairs fine, without swollen bases. *Involucral bracts* sparsely hairy, with hairs mostly marginal. *Ray floret ligules* c. 1 mm long, ±equal in length to involucre. *Pappus* on mature achenes absent or a minute cup to 0.1 mm long; *awns* rarely present on mature achenes. (Figure 3A–L)

*Selected specimens (c. 350 examined).* SOUTH AUSTRALIA: Walkers Flat, 3 Mar. 1964, *E.N.S. Jackson* 590 (AD, MEL); shores of Millbrook Reservoir, 11 Mar. 1962, *D.E. Symon* 2074 (AD); Wiela Stn opposite Chowilla, 9 May 1987, *D.E. Symon* 14342 (AD, CANB); c. 6 km S of Blanchetown, 19 Mar. 1973, *J.Z. Weber* 3409 (AD). QUEENSLAND: Warrego Hwy, 22 km NW of Dalby, 20 Mar. 1994, *A.R. Bean* 7616 (BRI); Turner Creek, 11.9 km N of Dalveen, 26 Jan. 1995, *A.R. Bean* 8211 (BRI, MEL, NSW); Burraburri Creek, 16 km W of Durong, 7 May 1992, *P.I. Forster* 9837 (BRI, MEL). NEW SOUTH WALES: Girilambone, Jan. 1900, *W. Baeuerlen s.n.* (AD, BRI, CANB, HO, MEL); 0.4 km S of Gurley Creek, on Moree–Narrabri road, 5 Jan. 1996, *A.R. Bean* 9490 (BRI); Tealmoy Waterhole, 5 Nov. 1987, *Peter G. Wilson* 148 & *D.I. Wilson* (CANB, MEL, NSW). VICTORIA: Little Piccaninny Creek, Dingee, 9 Nov. 1947, *F. Robbins* ACB38707 (MEL); Piangil, c. 40 km NW of Swan Hill, *R.V. Smith* 71/26 (AD, BRI, HO, K, MEL); Serendip, Lara, 21 Mar. 1963, *F. Swindley* 1559 (MEL).

*Distribution and habitat.* Widespread in Queensland, New South Wales, Victoria and South Australia, south of latitude c. 23° 20' S (Figure 2B). Found on heavy clay soils in damp situations (swamps, river flats, seepage areas) in grassland and woodland, at altitudes from sea-level to at least 470 m asl.

*Flowering and fruiting period.* Flowers and fruits recorded in all months.

*Conservation status.* Widespread and not at risk.

*Etymology.* From the Greek *platys* (broad) and *glossa* (tongue), referring to the size of the ligule, large in comparison to *E. prostrata*, the only other species recorded for Australia at the time.

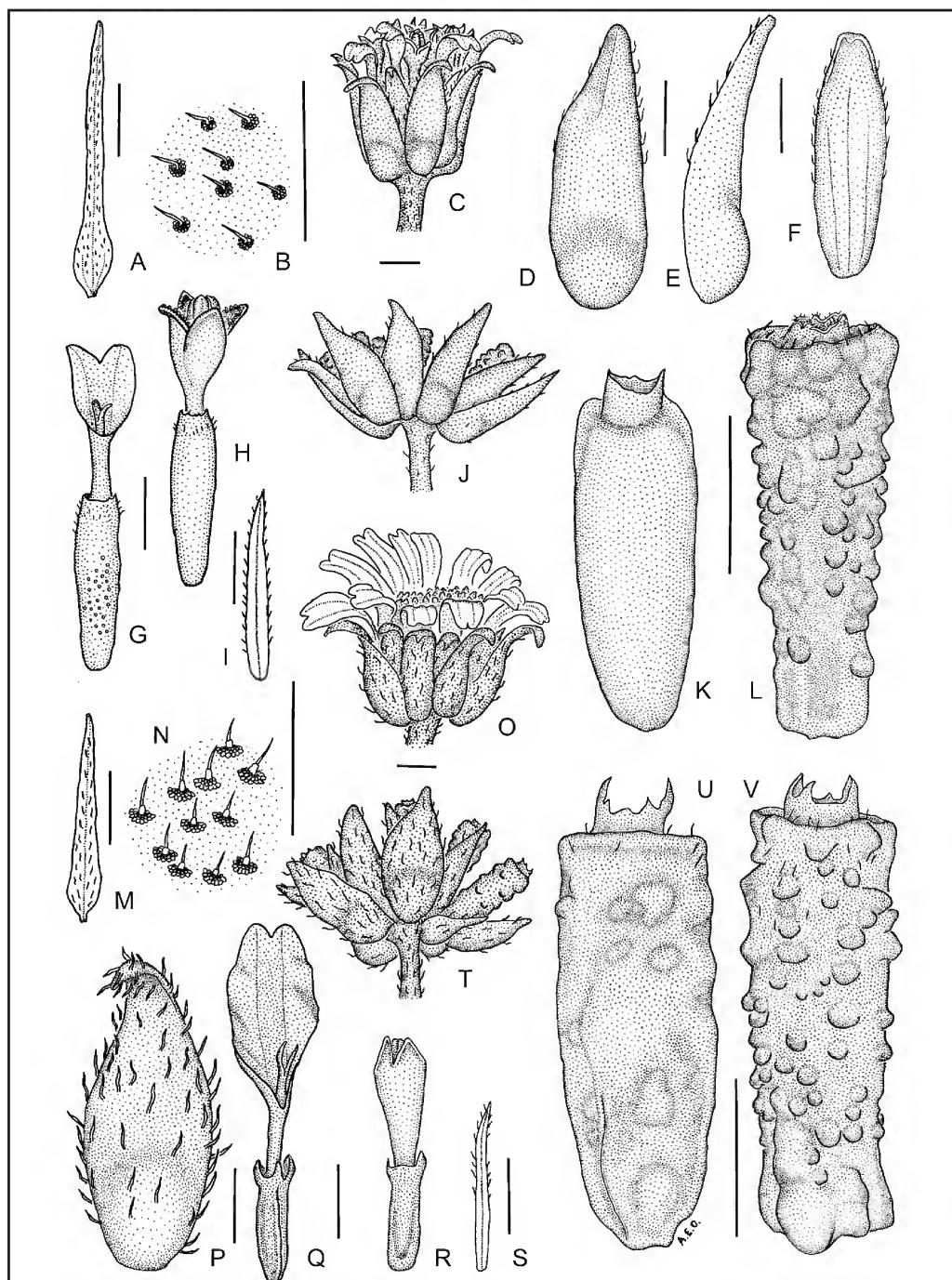


Figure 3. *Eclipta platyglossa*. A–L. subsp. *platyglossa*. A – leaf; B – appressed hairs on upper leaf surface; C – capitulum in flower; D – outer involucral bract; E – lateral view of outer involucral bract; F – inner involucral bract; G – ray floret; H – disc floret; I – palea; J – capitulum in fruit; K – immature achene; L – mature achene. M–V. subsp. *borealis*. M – leaf; N – erect hairs on upper leaf surface; O – capitulum in flower; P – outer involucral bract; Q – ray floret; R – disc floret; S – palea; T – capitulum in fruit; U – immature achene; V – mature achene. A–L based on A.R. Bean 8211, MEL; M–V based on H.S. McKee 8360, CANB. Scale bars: A, M = 1 cm; B–L, N–V = 1 mm. © ABRS, reproduced with permission.

## 2b. *Eclipta platyglossa* subsp. *borealis* E.W.Cross & Orchard, *subsp. nov.*

*Typus*: Fishfarm Road, c. 15 km east from Kununurra, Western Australia, 21 August 2000, A.A. Mitchell 6348 (*holo*: PERTH 6225217!; *iso*: CANB 571344!, DNA n.v.).

*Eclipta* ‘Humpty Doo entity’, *sensu* C.R. Dunlop, in I.D. Cowie, P.S. Short & M. Osterkamp Madsen, *Floodplain Flora* 184 (2000).

*Eclipta* sp. Humpty Doo (H.S. McKee 8360), *sensu* R.A. Kerrigan & D.E. Albrecht (eds), *Checklist N. Terr. Vasc. Pl. Sp.* [unpag.] (2007).

*Illustrations*. M.E. Lawrence in J.R. Wheeler (ed.), *Fl. Kimberley Reg.* 935, Figure 286N, 939, Figure 287I (1992), as *E. platyglossa*; C.R. Dunlop in I.D. Cowie, P.S. Short & M. Osterkamp Madsen, *Floodplain Flora* 185, Figure 36 (2000), as *Eclipta* ‘Humpty Doo entity’.

Leaves and stems semierect-pilose, the hairs coarse, with basal cell swollen. *Involucral bracts* moderately densely pilose, with similar hairs, both marginal and dorsal. *Ray floret ligules* c. 2 mm long, usually exceeding the involucre. *Pappus* on mature achenes a short cup to 0.3 mm long, often with 2–4 short, deltoid awns or teeth. (Figure 3M–V)

*Selected specimens* (c. 80 examined). WESTERN AUSTRALIA: Dampier Peninsula, Pender Bay at Weedong Lake, 22 June 1984, S.J. Forbes 2446 & K.F. Kenneally (MEL); 1 km N of main road to Disaster Bay, 35 km ENE Beagle Bay Mission, 7 May 1985, J.B. Martin 21 (CANB, PERTH); E end of billabong in front of Carlton Hill Station HS about 70 km N of Kununurra, 29 July 1994, A.A. Mitchell 3732 (PERTH). NORTHERN TERRITORY: Islands, Carpentaria, 1802–1805, R. Brown [Bennett no. 2112] (K); Dalywoi Bay, c. 10 km SSE of Yirrakala, 21 May 1996, I. Cowie 6964 (DNA, MEL); Calvert River mouth, 6 June 1987, P.K. Latz 10467 (DNA); Gove, 22 Aug. 1948, R.L. Specht 960 (AD, BRI, CANB). QUEENSLAND: Walsh River, c. 500 m upstream of Mungana–Wrotham Park road, 7 Feb. 1980, J.R. Clarkson 2777 (BRI, DNA, QRS); 11.5 km N of Bizant Ranger Base, Lakefield National Park, 27 May 1993, V.J. Neldner 4035 (BRI); Sweers Island, 18 Nov. 2002, M.B. Thomas SWI 112 & L. Pedley (BRI, DNA).

*Distribution and habitat*. Widespread in northern Western Australia and the Northern Territory, north of latitude 19° 40' S (Figure 2C). Found on heavy clay soils in swamps, marshes, drainage channels, and margins of pools, in grassland and woodland, including *Pandanus* swamp and the margin of salt flats and mangroves, at altitudes from sea-level to at least 400 m asl.

*Flowering and fruiting period*. Flowers and fruits recorded February–August.

*Conservation status*. Widespread and not at risk.

*Etymology*. From the Greek *boreis* and Latin *borealis* (northern): this subspecies is confined to northern tropical Australia.

*Affinities*. This subspecies is distinguished from subsp. *platyglossa* particularly by its coarser, longer, denser hairs, longer ligules, and by its leaves having a midrib more deeply sunken above and prominent below. It is geographically separated from the former by several degrees of latitude. However in other respects, especially leaf shape, flower and fruit characters, it closely resembles the typical subspecies, and is best considered distinct at subspecies rather than species level.

**3. \**Eclipta prostrata* (L.) L., *Mant. Pl.* 286 (1771). *Verbesina prostrata* L., *Sp. Pl.* 2: 902 (1753). Type citation: ‘Habitat in India’. Lecto: the plate: *Chrysanthemum maderaspatanum, menthae arvensis*.... in L. Plukenet, *Phytographia*, t. 118, f. 5, (1691), chosen by D.O. Wijnands, *Bot. Commelins* 74 (1983).**

*Verbesina alba* L., *Sp. Pl.* 2: 902 (1753). *Eclipta erecta* L., *Mant. Pl.* 286 (1771), nom. illeg., nom. superfl. *Eclipta alba* (L.) Hassk., *Pl. Jav. Rar.* 528 (1848). *Eclipta alba* var. *erecta* (L.) Miq., *Fl. Ned. Ind.* 2(1): 95 (1856). Type citation: ‘Habitat in Virginia, Surinamo’. Lecto: Herb. Linn. No. 1020.1 (LINN), photo!, chosen by W.G. D’Arcy, Flora of Panama (Family 184. Compositae), *Ann. Missouri Bot. Gard.* 62: 1102 (1975).

*Eclipta* sp. Perth (S. Lloyd s.n. 3/4/1998), *sensu* G. Paczkowska & A.R. Chapman, *W. Austral. Fl. Descr. Cat.* 161 (2000).

*Eclipta* sp. Gove (J.L. Egan 2784), NTHerbarium *sensu* R.A. Kerrigan & D.E. Albrecht (eds), *Checklist N. Terr. Vasc. Pl. Sp.* [unpag.] (2007).

*Illustrations.* A.L. Cabrera, *Fl. Prov. Buenos Aires* 4: 201, Figure 56 (1963), as *E. alba*; D.L. Nash, Heliantheae in *Fl. Guatemala, Fieldiana* 24(12): 521, Figure 66 (1976); H.E. Kleinschmidt & R.W. Johnson, *Weeds of Queensland* 382 (1977); T.D. Stanley & E.M. Ross, *Fl. SE Queensland* 2: 562, Figure 78A (1986); C.R. Dunlop in I.D. Cowie, P.S. Short & M. Osterkamp Madsen, *Floodplain Flora*, 185, Figure 36 (2000), as *Eclipta ‘Gove entity’*, and *E. prostrata*; R.P. Wunderlin & B.F. Hansen, *Atlas of Florida Vascular Plants* (2008) (<http://www.florida.plantatlas.usf.edu/Plant.aspx?id=3677>, accessed 20 June 2012); US Forest Service, Pacific Island Ecosystems at Risk (PIER) ([http://www.hear.org/pier/species/eclipta\\_prostrata.htm](http://www.hear.org/pier/species/eclipta_prostrata.htm), accessed 20 June 2012).

Erect or decumbent perennial *herb* ( facultatively semiaquatic), (15–)30–60(–100) cm tall; *stems* weak, scabrous, rooting adventitiously when prostrate or submerged. *Leaves* ±sessile, distant, lanceolate, narrowly ovate or elliptic, variable in size, usually 20–65(–170) mm long, (2–)5–20(–40 mm) wide, gradually tapered to base, entire to shortly and irregularly dentate, both surfaces appressed-pilose; hairs 0.4–0.6 mm long, slender throughout. *Peduncles* 1–7 cm long. *Involucral bracts* 8–10, ovate (outer) to lanceolate (inner), striate, 3–4 mm long, appressed-pilose. *Ray florets* numerous (30–70); ligules white, linear, 1–2 mm long, usually 2-lobed (some unlobed). *Disc florets* numerous (30+) white. *Achenes* 2.0–2.3 mm long, 0.8–1.0 mm wide, compressed-cuneate, weakly 3- or 4-angled, strongly tuberculate, with 2 cartilaginous margins, scattered hairs at apex; *pappus* absent or a minute ciliolate cup with 2 or 3 soft tooth-like awns. (Figure 4)

*Selected specimens Australia (c. 300 examined).* WESTERN AUSTRALIA: Broome garden, 18 June 1997, C. Brockway 166B (PERTH); near Riverton Bridge, Canning River, Wilson, 16 Mar. 1998, B.J. Lepisch 3880 & T.R. Lally (CANB, PERTH); banks of Canning River, Liege St., Cannington, 23 May 1998, S. Lloyd s.n. (AD, CANB, BRI, MEL, PERTH); 25 km from Kununurra, 17 July 1992, A.A. Mitchell 2630 (CANB, PERTH). NORTHERN TERRITORY: Nhulunbuy Lagoon, Gayngaru Walk, 16 Oct. 1993, J.L. Egan 2784 (DNA); Fogg Dam, 24 Nov. 1998, J. Risler & R.A. Kerrigan 25 (DNA); Oenpelli, 25/26 Sep. 1948, R.L. Specht 1063 (BRI, CANB, MEL, PERTH). QUEENSLAND: 1 km N of Daintree Ferry crossing, 29 Feb. 1996, B. Gray 6537 (QRS); Boyne River near junction with Derrabungy Creek, c. 25 km S of Mundubbera, 11 July 1996, W.J. McDonald 6195 & D.J. Baumgartner (BRI); c. 7 km WSW of Moura, 16 June 1999, A.B. Pollock 733 & M. Edington (AD, CANB, NSW). NEW SOUTH WALES: Lismore Dam, 11 Nov. 1971, N.C.W. Beadle s.n. (NE); Tuckean Island, W of Wardell, 2 Apr. 2001, A.R. Bean 17572 (BRI); Moore Park, 1.6 km N of Old Grevillia, 4 Sep. 1973, R. Coveney 5132 (BRI, CANB, K).

*Selected specimens extra-Australia (38 examined).* PORTUGAL: Salwaterra de Magos, 24 Sep. 1958, F. Fontes 270 (CANB). RWANDA: Kigali, 26 Feb. 1958, G. Troupin 6560 (CANB). OMAN: Zeak, 26 Oct. 1981, J.R. Maconochie 2917 (CANB). DIEGO GARCIA (BIOT): Point Marianne, 24 May 1979, A. Field 161 (CANB). IRAQ: Baghdad Liwa, 15 Nov. 1958, S. Agnew & A.D.Q. Agnew 191 (CANB). CHINA: Jiangxi Prov., Shahe, 13 Oct. 1995, C.-M. Tan 95860 (CANB). PHILIPPINES: White Beach, Leyte, 5 May 1957, G.M. Frohne PNH35142 (CANB). INDONESIA: E Java, Kudus, c. 1930, C.S. Backer 816 (CANB); Timor, Fatunnasi, Soe, 14 Jan. 1975, H. Wiriadinata 410 (CANB). PAPUA NEW GUINEA: Kunini village, 6 May 1986, J. Simaga 679 (CANB). HAWAII: Halalii Lake, 1 Apr. 1949, H. St. John 23653 (CANB). UNITED STATES OF AMERICA: Louisiana, Audubon Park, New Orleans, 20 Nov. 1949, J. Ewan 18276A (CANB). BAHAMAS: Thompson Boulevard, New Providence Is., 27 Sep. 2000, E. Freid 00-361 (CANB). PANAMA: David airport, 14 Dec. 1966, W.H. Lewis et al. 772 (CANB).

*Distribution and habitat.* A pantropical and warm temperate weed; a presumed native of South America. In Australia, widespread in Queensland, the Northern Territory and north-east New South Wales; in Western Australia rare in the Kimberley and near Perth (Figure 2D). The earliest record of this species in Australia is from the Brisbane River (*F. Mueller s.n.*, July 1855 and Dec. 1856, MEL). By 1865–66 it was known from Rockhampton (*A. Dietrich s.n.* & 891, MEL), by 1869 from Mackay (*A. Dietrich* 2463, MEL), and by the 1870s–1890s from Port Darwin (*Holtze s.n.*, MEL). Found in wet areas (floodplains, drainage lines, lake and river margins), on heavy clay soils, at altitudes from sea-level to at least 1000 m asl. When growing near stagnant water, it facultatively sends submerged, adventitiously rooting shoots out into the water, and from these are produced erect, emergent flowering branches.

*Flowering and fruiting period.* Flowers and fruits recorded in all months.

*Conservation status.* Widespread and not at risk.

*Etymology.* From the Latin *prostratus*, (prostrate) referring to its annual, weak, sprawling stems arising from a perennial, woody rootstock.

*Common name.* White Eclipta.

*Notes.* Leaf size in this species is very variable. Plants growing in swampy conditions can have leaves 9–17 cm in length, whereas most collections have leaves 2–6.5 cm long. One of these large-leaved forms was given the phrase name *Eclipta* sp. Perth (S. Lloyd s.n. 3/4/1998), based on a collection by S. Lloyd from Cannington. Similarly, the plant provisionally referred to as *Eclipta* sp. Gove (J.L. Egan 2784) from the Northern Territory is also merely a minor morphological variant of this species. This variation has led to the description of many local variants worldwide, all now included in a very extensive synonymy. See, for example, GCC (Flann 2009–) which contains c. 100 synonyms of *E. prostrata*.

The illustration of '*Eclipta alatocarpa*' in the *Flora of Central Australia* (Jessop 1981: 381) is *E. prostrata*.

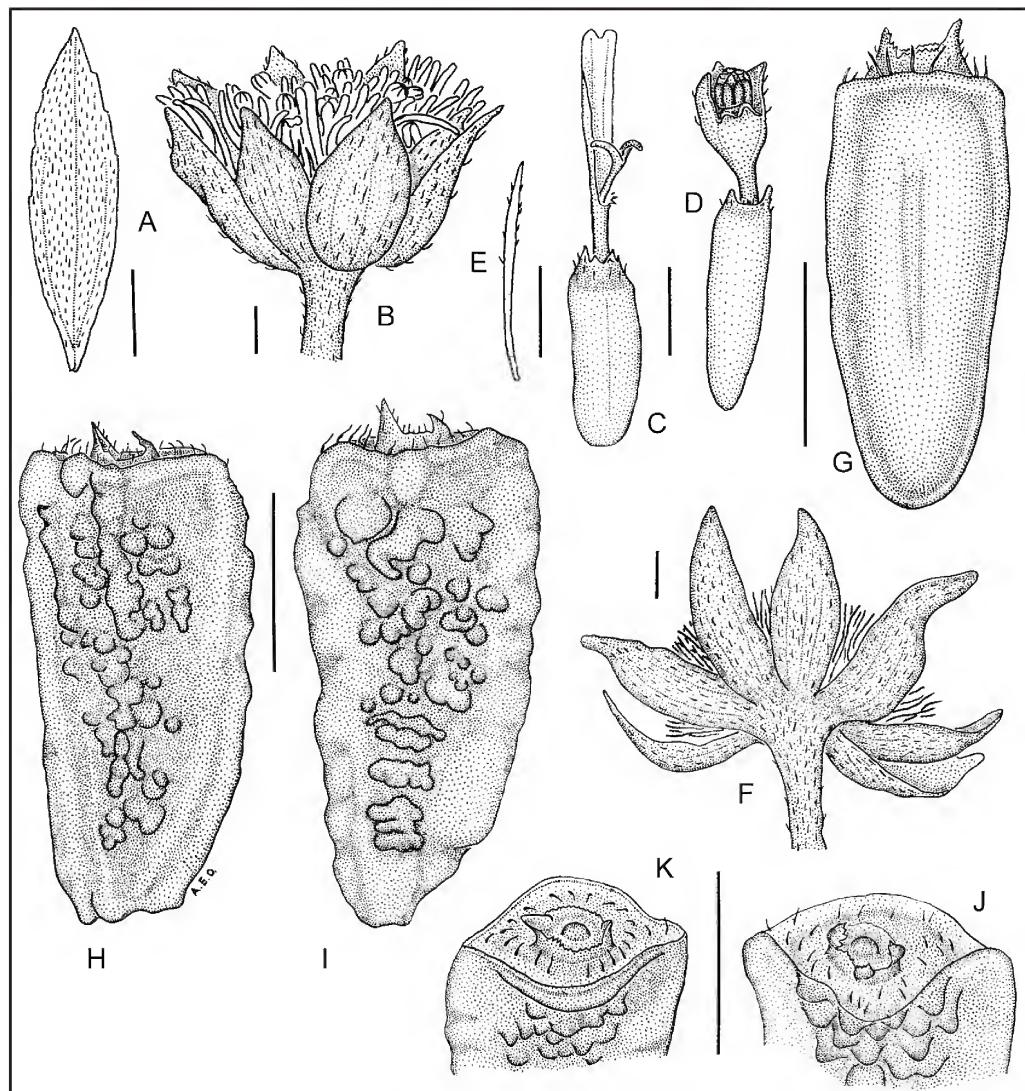


Figure 4. *Eclipta prostrata*. A – leaf; B – capitulum in flower; C – ray floret; D – disc floret; E – palea; F – capitulum in fruit, viewed from below; G – immature disc achene; H – mature ray achene; I – mature disc achene; J – oblique view, apex of ray achene; K – oblique view, apex of disc achene. All based on A. Fraser 353, CANB. Scale bars: A = 1 cm; B–K = 1 mm. © ABRS, reproduced with permission.

### The South American endemic species

The following brief descriptions are provided in order to provide comparative data for extra-Australian species, but as they are based on a combination of literature sources and very limited specimens, should not be considered comprehensive. Synonymy only includes those names for which authentic material has been examined. For a more complete synonymy see GCC (Flann 2009–).

**Eclipta elliptica** DC., *Prodri.* 5: 491 (1836). *Type citation:* ‘in Brasiliae prov. Rio-Grande. (v.s. in h. Mus. reg. Par. ex h. Mus. imp. Bras. n. 1024).’ (*holo*: Brésil. Province de Rio-Grande. (Herbier Impérial du Brésil No. 1024), *C. Gaudichaud s.n.*, 1833, P 2534514 photo!).

*Eclipta peduncularis* J.Rémy, in C.Gay, *Fl. Chil.* 4(1): 113 (1849). *Type citation:* ‘Se cria igualmente in las provincias del norte [Gay].’ (*iso*: Chile, *C. Gay s.n.* (K 487528 ex herb. Paris!); Chili, 1839, *C. Gay s.n.* (P 2534517 photo!)).

*Illustrations.* J.G. Baker in C.F.P. von Martius, *Fl. Brasil.* 6(3): t. 56(II) (1884); J. Arechavaleta, *Fl. Uruguaya* 3: 319, Tab. LXV (1906).

Perennial, often prostrate, *herb* 30–50 cm tall; stems sparsely pilose. *Leaves* subsessile, distant, elliptic, (10–)20–30 mm long, 8–10 mm wide, entire, long-attenuate at base, obtuse, sparsely pilose; hairs appressed, on multicellular swollen bases. *Peduncles* 40 mm long. *Involucral bracts* c. 8, lanceolate to narrowly ovate, weakly longitudinally veined, 6 mm long, sparsely pilose. *Ray florets* numerous (c. 25 or more), in 2 series; ligules white to creamy white, c. 2 mm long, 0.7 mm wide. *Disc florets* numerous (c. 20), white to creamy white. *Achenes* 3 mm long, 2 mm wide, oblong, trigonous (ray achenes) or quadrangular (disc achenes), yellow-brown, smooth or becoming slightly rugose; *pappus* absent or of 2 short awns. (Figure 5A–L)

*Specimens examined.* URUGUAY: Montevideo, Oct. 1858, *M. Gilbert* 49 (K); Pocitos/Malvin, Nov. 1924, *G. Herter* 76231 (K); *loc. cit.* 9 Dec. 1924, *G. Herter* 70203 (K); Montevideo, 1826–30, *Capt. King s.n.* (*Voyage of Adventure & Beagle*), (K). BRAZIL: Prov. Rio Grande do Sul, 1816–21, *St Hilaire* C2/1779 & 2216 (P 2533513 & 2534512 photos!). ARGENTINA: Prov. Buenos Aires, Campana, 27 Nov. 1938, *W.J. Eyerdam & A.A. Beetle* 23099 (K); Prov. Buenos Aires, 77 km SE of La Plata, 9 Dec. 1938, *W.J. Eyerdam et al.* 23397 (K).

*Distribution and habitat.* Found in Brazil, Uruguay, Paraguay, Argentina and northern Chile, in semishaded grassy habitats in heavy moist loam.

*Flowering and fruiting period.* Flowers present October–November; fruits November–December.

*Etymology.* From the Latin *ellipticus* (elliptical), referring to the blunt, elliptical leaves, as opposed to the acute, lanceolate leaves of the more common *E. prostrata*.

**Eclipta leiocarpa** Cuatrec., *Revista Acad. Colomb. Ci. Exact.* 9: 240 (1954). *Type citation:* ‘Colombia, Dep. Cundinamarca: San Antonio de Tena, alrededores del puente sobre el río Bogotá, 1400–1500 m. alt. Hierba higrófila, flor blanquecina. Colect. 10-III-1940 J.Cuatrecasas 8255 (Holotypus F).’ (*holo*: F 49427F photo!; *iso*: COL 4912 photo!).

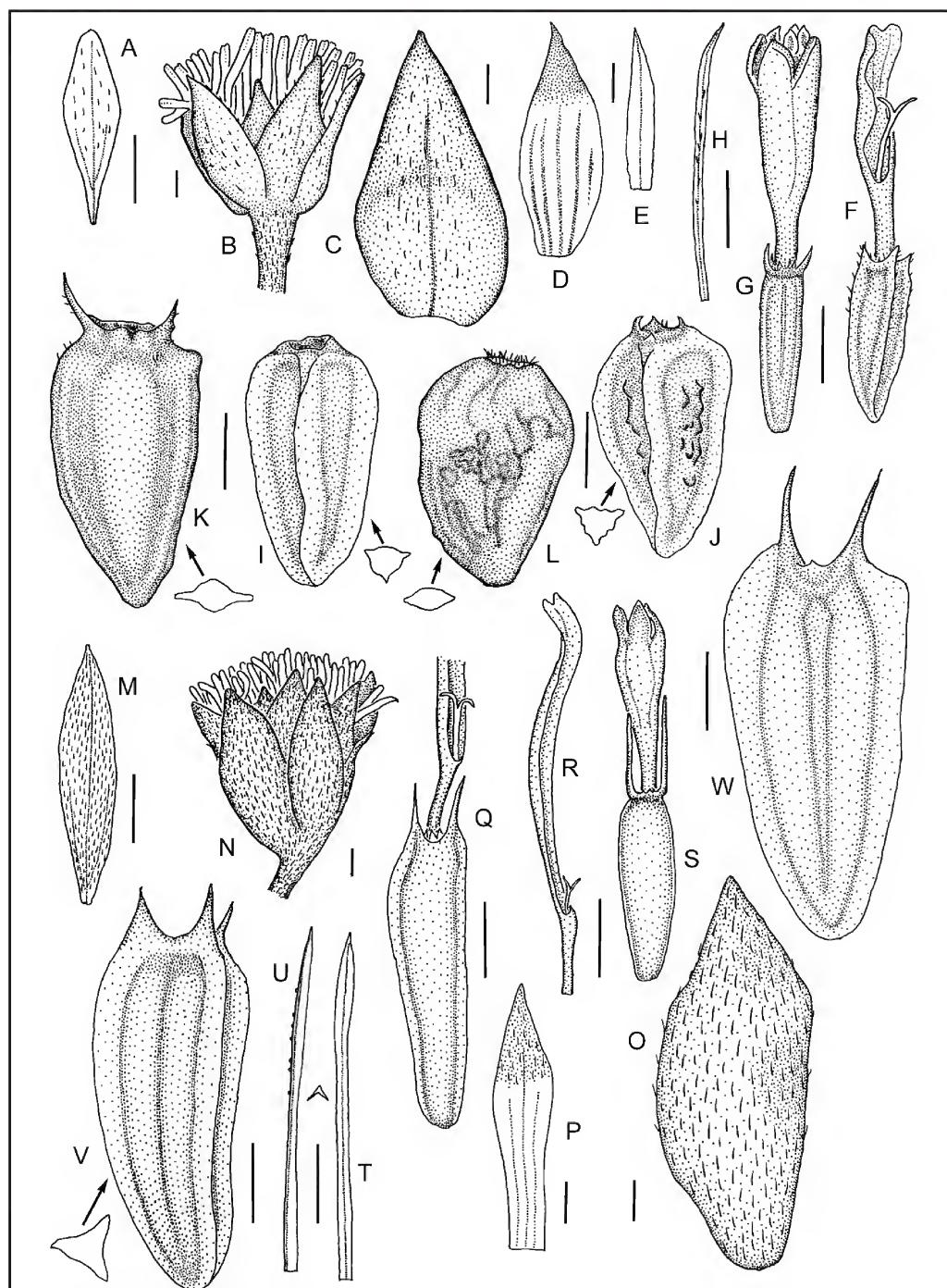


Figure 5. Endemic South American species of *Eclipta*. A–L. *Eclipta elliptica*. A–leaf; B–capitulum in flower; C–E involucral bracts, outer to inner; F–ray floret; G–disc floret; H–palea; I, J–ray achenes; K, L–disc achenes. M–W. *Eclipta megapotamica*. M–leaf; N–capitulum in flower; O–outer involucral bract; P–inner involucral bract; Q–ovary of ray floret; R–corolla of ray floret; S–disc floret; T–palea dorsal view; U–palea lateral view; V–ray achene; W–disc achene. A–L based on *G. Herter* 76231, K; M–W based on *J.F.J.Sello* 2504, K. Scale bars: A, M = 1 cm; B–L, N–W = 1 mm.

Erect *herb*; *stems* sparsely pilose. *Leaves* subsessile, distant, lanceolate, 100 mm long, 35 mm wide, coarsely serrate, long-attenuate at base, acute, sparsely pilose; hairs appressed, on swollen bases. *Peduncles* 20–30 mm long. *Involucral bracts* 8 or 9, ovate or oblong-ovate, with c. 9 distinct longitudinal veins, 3.5 mm long, glabrous. *Ray florets* numerous, in 2 series; ligules white, linear, c. 2 mm long. *Disc florets* numerous, white. *Achenes* only developing from disc florets, c. 2 mm long, 1 mm wide, oblong, quadrangular, silvery grey, smooth; *pappus* absent (achenes pilose apically).

*Specimens examined.* Only on-line photographs of the holotype and isotype have been seen.

*Distribution and habitat.* A species so far only recorded from Colombia. Described as hygrophilous.

*Flowering and fruiting period.* Flowers and fruits present in March.

*Etymology.* From the Greek *leios* (smooth) and *carpos* (fruit).

***Eclipta megapotamica*** (Spreng.) Sch.Bip. ex S.F.Blake. *Verbesina megapotamica* Spreng., *Syst. Veg.* 3: 578 (1826). *Type citation:* ‘ad fl. magnum Amer. Austr. (rio Grande). Sello.’ (possible type: *Verbesina megapotamica*, [F.J]Sello (‘Sprgl! herb. 1946’), ex herb. Schultz Bip., ex herb. E. Cosson (P 2534364 photo!)).

*Eclipta lanceolata* DC., *Prodr.* 5: 491 (1836). *Type citation:* ‘in Brasiliae prov. Rio-Grande. (v.s. in h. Mus. reg. Par. ex h. Mus. imp. Bras. sub n. 1007.’ (holo: Brésil, Province de Rio-Grande, 1833, C. Gaudichaud s.n. (Herbier Impérial de Brésil n. 1007) (P 2534365 photo!)).

*Eclipta lanceolata* var. *longifolia* Baker, in C.F.P. von Martius, *Fl. Brasil.* 6: 171 (1884). *Type citation:* ‘Habitat prope Montevideo: Arechavaleta n. 4113, Sello n. 2498.’ (syn: Montevideo, en los Cariados ..., Diciembre 1876, Arechavaleta 4113 (K 487529! & 487530!)).

*Illustrations.* J.G. Baker in von C.F.P. von Martius, *Fl. Brasil.* 6 (3): t. 56(I) (1884), as *E. lanceolata*; A.L. Cabrera, *Fl. Prov. Buenos Aires* 4: 203, Figure 57A–C (1963).

Erect or procumbent perennial *herb* 30–60 cm tall; *stems* sparsely pilose. *Leaves* subsessile, distant, lanceolate to narrowly ovate, 30–50(–80) mm long, 10–15 mm wide, entire, long-attenuate at base, acute, appressed-pilose; hairs fine, each seated on a ring of tiny cells. *Peduncles* 100–160 mm long. *Involucral bracts* c. 15, lanceolate to narrowly ovate, midrib present, 8–9 mm long, appressed-pilose. *Ray florets* numerous, in 2 series, ligules creamy white (sometimes described as ‘amarillo’), linear, 2–3 mm long. *Disc florets* numerous, creamy white. *Achenes* 4(–6) mm long, 2 mm wide, oblong, 3-angled (ray achenes) or 2-angled and compressed (disc achenes), with a narrow yellowish wing on angles, extended apically into 2 or 3 short awns; body of achenes dark brown, smooth, glabrous; *pappus* absent or of 1 or 2 very short lobes between awns. (Figure 5M–W)

*Specimens examined.* URUGUAY: Rio del Plata, Mar. 1890, *J. Arechavaleta* 51 (K). BRAZIL: Brasilia, [F.J]Sello 2502 (K); Brazilia, Passo do [?Jauny], Bankado, Sello 2504 (K); Barra de Sta Lucia, Oct. 1876, M. Fruchard s.n. (P 2534359 photo!); Rio Grande do Sul, Porto Alegri, zwischen Navegantes und Saõ Joaõ, 2 Dec. 1897, E.M. Reineck & J. Czermak 154 (P photo!); Province de Rio Grande do Sul, 1816–1821, A. de St Hilaire 2667 (P photo!).

*Distribution and habitat.* Found in southern Brazil, Uruguay and north-eastern Argentina, in the catchment of the Rio Grande, in damp, humid communities, probably among grasses.

*Flowering and fruiting period.* Flowering and fruiting in December–March.

*Etymology.* From the Greek *megas* (big) and *potamos* (river), meaning from the Rio Grande.

*Notes.* Specimens seen during this study appeared to have white or creamy white florets, but Arechavaleta (1906) and Cabrera (1963) described them as ‘amarillas’, i.e. yellow.

### Summary key

The following key serves to distinguish the six species of *Eclipta* worldwide, as recognised in this paper.

1. Florets yellow
  2. Achenes winged, smooth or rugose; involucral bracts pouched or not pouched at base
    3. Wings narrow, produced into short awns apically; body of achene smooth; involucral bracts not pouched at base ..... **E. megapotamica**
    - 3: Wings broad, forming a castellated cup apically but lacking awns; body of achene rugose; involucral bracts weakly pouched at base ..... **E. alatocarpa**
  - 2: Achenes unwinged, ±cylindrical, rugose; involucral bracts pouched ..... **E. platyglossa**
- 1: Florets white
  4. Achenes winged ..... **E. megapotamica**
  - 4: Achenes not winged
    5. Leaves entire or almost so; achenes brown to yellow-brown; involucral bracts with, at most, 1 or 3 indistinct longitudinal nerves
      6. Leaves blunt, elliptic ..... **E. elliptica**
      - 6: Leaves acute, usually lanceolate or ovate, rarely elliptic ..... **E. prostrata**
    - 5: Leaves coarsely toothed; achenes silvery grey; involucral bracts ovate to oblong-ovate with c. 9 distinct longitudinal nerves ..... **E. leiocarpa**

### Acknowledgements

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**Allan Cunningham's Timor collections****Anthony E. Orchard<sup>1</sup> and Theresa A. Orchard<sup>2</sup>**<sup>1</sup>c/o Australian Biological Resources Study, GPO Box 787, Canberra, Australian Capital Territory 2601<sup>2</sup>PO Box 3427, Weston Creek, Australian Capital Territory 2611<sup>1</sup>Corresponding author, email: tony.orchard@environment.gov.au**Abstract**

Orchard, A.E. & Orchard, T.A. Allan Cunningham's Timor collections. *Nuytsia* 23: 63–88 (2013). The visits of Allan Cunningham to Timor in 1818 and 1819, at the conclusion of Lieutenant Philip Parker King's first and second survey voyages to the north coast of Australia, are summarised, and surviving collections held in the Natural History Museum herbarium and the herbarium, Royal Botanic Gardens, Kew are listed. The significance of the various labels found on these sheets is discussed.

**Introduction**

Allan Cunningham (1791–1839) is justly celebrated as one of the foremost botanists and explorers of Australia in the first third of the 19th century. His collections of seeds, bulbs and living plants sent to Kew over three decades introduced hundreds of Antipodean plants to cultivation in Europe, in the process restoring Kew to the position of leading European botanical garden, while his dried specimens were used by him, and by many other botanists, to describe a substantial part of the Australian flora. These specimens are now found in at least 26 herbaria around the world.

Not so well known is the fact that Cunningham also collected outside of Australia. On his journey from England to New South Wales he spent nearly two years (1814–1816) collecting in Brazil with another Kew botanist, James Bowie. Then, on his arrival in Sydney he was almost immediately co-opted to accompany Lieutenant Phillip Parker King on the latter's surveys of the north-east, north-west and south-west coasts of Australia between 1817 and 1822. On these voyages the surveys touched at Kupang [Coepang, Coupang], west Timor, twice (5–11 June 1818 and 1–9 November 1819), as well as at Mauritius (26 September–13 October 1821). In addition, Cunningham twice visited New Zealand (August–December 1826 and September–October 1838), and Norfolk Island (including Phillip Island) from May–September 1830. In all of these places Cunningham collected propagation material for Kew, and dried specimens and seeds for Kew and Sir Joseph Banks/Robert Brown (the latter dried collections are now in the Natural History Museum).

The present authors are in the process of compiling a detailed biography of Cunningham, which will include some details of his collections and collecting activities. As part of this research, the holdings of the Natural History Museum (BM) and Kew (K) were manually searched for surviving Cunningham specimens, and these have been matched, where possible, with Cunningham's surviving shipping lists of specimens. The shipping lists prepared by Cunningham bore only his field determinations, and are frequently obscure, with nothing to link individual entries to modern names. By working from surviving

specimens, however, it has been possible in most cases to match these lists to current names, leading to a more useful interpretation of Cunningham's explorations.

This paper on the Timor collections is the first of an intended series in which Cunningham's lists will be reinterpreted and updated, and surviving specimens in K and BM listed. In addition, the various labels appearing on these specimens will be discussed, allowing future users to interpret the often tortuous path that some specimens traced from Cunningham, through various hands, to their current lodging.

### The circumstances leading to the Timor visits

The establishment of the British colony at Port Jackson is popularly believed to have been driven by the need to export a growing prison population in England far beyond the seas, to a place from which it was hoped most would never return. However, another, and perhaps more urgent reason, was to forestall the perceived threat of French (and perhaps Spanish) colonisation of the newly discovered continent. This led, in 1800, to the despatch of a survey expedition in the *Investigator*, led by Matthew Flinders, around the coasts of New Holland. Flinders' survey encompassed only the south coast, part of the east coast, and the north coast as far as eastern Arnhem Land, where, because of the poor state of the *Investigator*, he was obliged to abandon the survey, seek temporary repairs in Timor, and return to Sydney. He was accompanied on this voyage by Robert Brown, who collected intensively at all landfalls, including Timor.

The Napoleonic Wars frustrated any attempt to continue the surveys, until 1817. Lieutenant King was then charged with filling the gaps on the (English) charts, particularly in the north-west of the continent. Fortunately, Allan Cunningham had arrived in Sydney late in 1816, as the King's Collector for Kew, and Banks arranged for him to join King's survey voyage, a circumstance that succeeded beyond anyone's imagination. Cunningham and King were of about the same age (26 and 25 respectively), and worked together well, forming a close lifelong friendship.

The first voyage (22 December 1817–29 July 1818) visited King Georges Sound, Exmouth Gulf and the Dampier Archipelago, before serious surveying began in northern Arnhem Land, picking up more or less where Flinders and Brown had left off 14 years earlier. With the turn of the season, the expedition called at Coepang, Timor, from 4–13 June 1818, to replenish supplies before returning to Sydney. Cunningham took the opportunity to collect in the vicinity of the town and along the river from 6–11 June, with the help of a Malay servant supplied by the Dutch administrator. (Figures 1–3)

The second voyage (8 May 1819–12 January 1820) surveyed the east coast of Queensland before examining the northern coast of Arnhem Land westwards from the area seen the previous year, as far as Port Warrender. Again, at the end of the survey King visited Timor (1–9 November 1819) to resupply his ship, and Cunningham was able to collect specimens and seeds in the vicinity of the town on 3–5 November. The two collections were thus complementary, being seasonally five months apart, allowing Cunningham to collect the same species at different stages of development.

### Distribution of the specimens

Cunningham's employment contract with the King (George III), via Treasury, was principally framed for him to deliver a wide range of seeds, bulbs and living plants for Kew. However, Banks (who had been given oversight of Cunningham's activities) had also specified that dried specimens

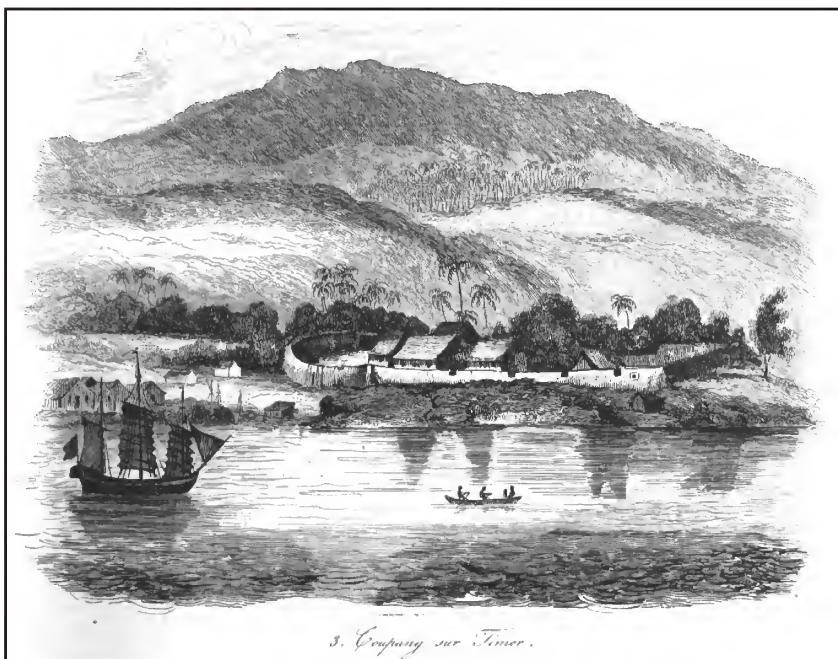


Figure 1. Coupang, the Dutch fort and village, c. 1825. Sainson engraving, from J.S.C. Dumont d'Urville, *Voyage Pittoresque Autour du Monde*, vol. 2: pl. XXVII (1839).

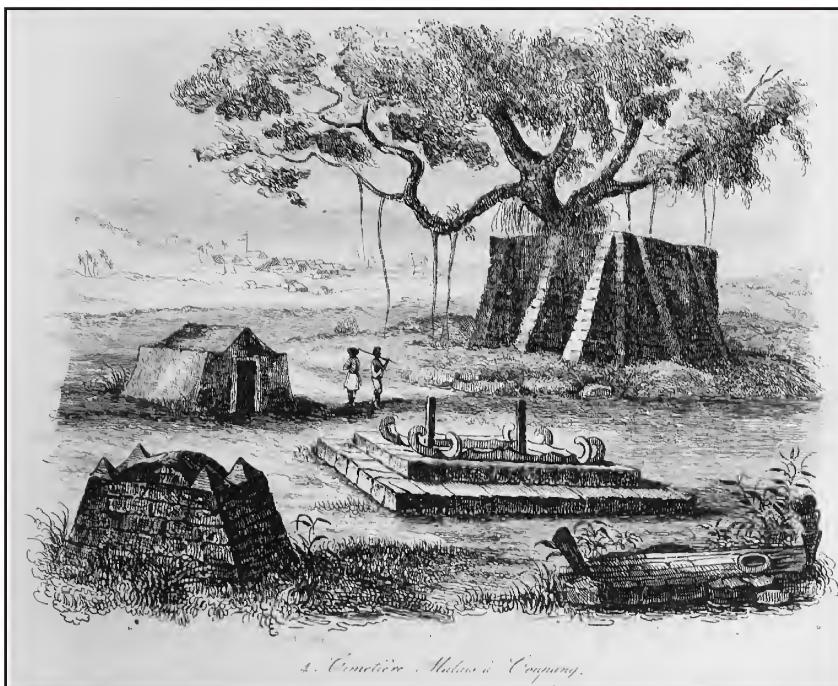


Figure 2. Coupang, the Malay Cemetery, village of Coupang in the background, c. 1825. Sainson engraving, from J.S.C. Dumont d'Urville, *Voyage Pittoresque Autour du Monde*, vol. 2: pl. XXVII (1839).

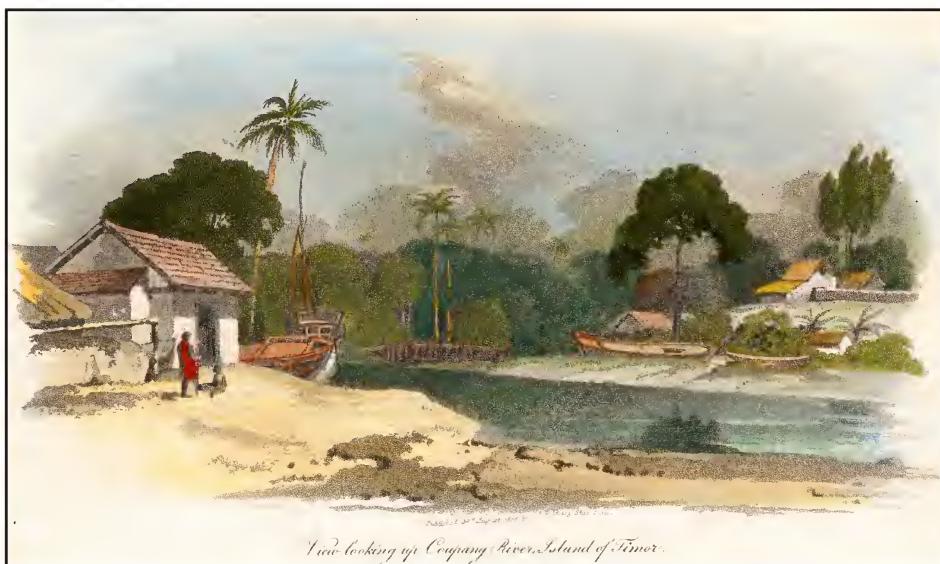


Figure 3. ‘View looking up Coupang River, Island of Timor’. Print by T. Mediana, published 30 August 1806, by J. Gold, 103 Shoe Lane, later hand coloured.

should be collected wherever possible, to aid in identification of the living material sent to Kew. It must be remembered that at this time knowledge of the Australian flora was in its infancy, with only Labillardiere’s *Specimen* (1804–1806) and Robert Brown’s *Prodromus* (1810) generally available. Cunningham’s sole reference books in Brazil had been Aiton’s *Hortus Kewensis* (1810–1813) (on which he had worked himself before leaving Kew), and Persoon’s *Synopsis* (1805–1807). These two books underpinned much of his early work in Australia as well. Brown had access to his own collections from Australia, and those of Banks and Solander, but both these holdings were limited in geographical scope. Cunningham had no herbarium reference materials other than his own collections.

Cunningham was therefore expected to make at least two duplicate specimens of his dried collections, one for Brown/Banks at Soho Square, the other for Aiton at Kew. Banks died on 19 June 1820, but Cunningham continued to send material to Brown, as well as to Aiton. Cunningham expected that Brown would reply to him with determinations of material received, but this in fact almost never occurred. In addition, Cunningham kept at least one additional replicate of his collections for his own reference herbarium, and if material was plentiful and in good condition, he often made additional replicates. These additional replicates were, at least in part, sent to Aiton at Kew. There Allan Cunningham’s brother Richard, Aiton’s emanuensis/private secretary, examined them, provided determinations, and frequently sent some to other leading botanists, most notably William Hooker, then Professor of Botany at Glasgow. It is likely that Richard Cunningham also provided Allan Cunningham with redeterminations of collections received, but this is unclear. Richard’s numerous letters to his brother have mostly not survived.

At his own request, Cunningham was recalled to England in 1831, and spent almost six years in a cottage at Strand-on-the-Green near Kew, sorting through his collections, writing some of them up, and distributing them to leading botanists in the UK and Europe (particularly to de Candolle). This activity increased when in 1836 he was recalled to New South Wales as Colonial Botanist to replace his brother, killed near the Bogan River on Mitchell’s 1835 expedition. However Cunningham retained

his own reference herbarium, at least, and took this with him back to New South Wales (In a letter to Lindley (Cunningham 1836) he revealed that his 'extra baggage', over and above his cabin baggage, consisted of 10 cases, presumably books and specimens.). In 1837, after less than a year as Colonial Botanist, Cunningham resigned from the post, and pursued private collecting in New South Wales and New Zealand, adding to his collections, but sending no material back to Kew or to Brown. He died in Sydney on 27 June 1839.

At a later date a set of Cunningham's specimens was also deposited with the Linnean Society of London. The timing and precise origin of this donation has not been determined. Some at least came to them via Cunningham's Executor, Robert Heward. Sometime between 1838 and 1841, Heward donated to the Linnean Society 'An extensive collection of dried plants, found in New Zealand by the late Allan Cunningham, Esq, F.L.S.' (*Transactions of the Linnean Society* 18: 726 (1841)); in 1844–1846 'Dried Specimens of Australian Myrtaceae, chiefly collected by the late Mr Allan Cunningham, F.L.S., Colonial Botanist, New South Wales.' (*Transactions of the Linnean Society* 20: 508 (1851)); and in 1848–1852 'Dried Specimens of Australian Leguminosae, including nearly 100 additional species of Acacia; collected by the late Allan Cunningham Esq., F.L.S.' (*Transactions of the Linnean Society* 21: 349 (1855)). In 1863 the Linnean Society resolved to dispose of its miscellaneous uncurated herbarium material, and it was sent for auction. However the 'arranged' Australian Herbarium was kept at this time (Linnean Society Council Minutes, 5 March 1863). Then, in 1915, the general secretary of the Society again raised the question of the Australian Herbarium, which had been put together by the Society's Librarian, Mr Richard Kippist. This collection was apparently never consulted, and lacked proper cabinet protection. It was resolved to offer the collection to Mr J.H. Maiden of Sydney, NSW, after the names had been verified under the superintendence of Dr Staph, the Society's Botanical Secretary (1908–1916), who did so (Linnean Society Council Minutes, 6 May 1915). This material was sent to Kew for onward despatch to Sydney. From Kew acknowledgement of receipt of two cases of Australian plants was shortly afterwards received from the Director, Sir David Prain (Linnean Society Council Minutes, 3 June 1915). The war may have interrupted the planned despatch of the collection to Sydney, leading to it being broken up. The Accessions Register of the Natural History Museum has an entry for 23 October 1915 (DF413/19: 94): '163 Specimens of Australian plants from the Council of the Linnean Society, through the Director, Royal Gardens, Kew.' There was a side note: 'i.e Ranunculaceae–Rubiaceae selected from list'. Other specimens from this source are now also to be found in Kew. In both cases they bear a small printed label 'PRESENTED BY THE LINNEAN SOCIETY 1915'. A large part of this Australian Herbarium was Cunningham material, although other collectors (e.g. R.C. Gunn, A. Burnett, J.E. Ker, and others) were also represented. Some Kew collections from these other collectors (but not Cunningham) bore an alternative larger label 'HERBARIUM KEWENSIS/HERBARIUM AUSTRALIENSE./Presented by the LINNEAN SOCIETY, 1915'. At least one of these sheets did eventually make it to Australia. In CANB there is a sheet of *Stenanthera pinifolia* R.Br., collected by Stephenson (No. 5, 6) in NSW in 1844. It bears the second type of label, and seems to have come to CANB as exchange from K.

On Cunningham's death in Sydney in 1839, his possessions were returned to England by his friend and former ship commander P.P. King, and disposed of by his Executor, Robert Heward. Heward at first distributed some duplicates from the herbarium to various botanists (Lindley, Bentham, W. Hooker and others), but the majority of the surviving material was organised by him, labelled by reference to Cunningham's journals and correspondence, and then in 1862 donated *en bloc* to Kew. The total donation was of 3,827 collections (Heward 1862), including 75 specimens from Timor and Mauritius.

In the meantime, Aiton had retired from Kew in 1841. The Kew herbarium collections of Cunningham (and James Bowie) had been housed in a small shed near Aiton's office. In 1840, shortly before Aiton's

retirement, Robert Brown visited Kew and claimed these collections for the British Museum. However, Kew was not without Cunningham material for long. William Hooker took up the post of Director of Kew in 1841, bringing with him his private herbarium. In 1854 Bentham presented his herbarium of about 100,000 sheets (including some Cunningham material obtained directly from Cunningham or via Heward), to Kew, and this with other donations became the foundation of the official Kew herbarium. On the death of William Hooker in 1865, his private herbarium, which had been housed at Kew, was purchased by the state (1866), and another batch of Cunningham specimens thus became part of the Kew herbarium.

In summary, therefore, the two main recipients of Cunningham's herbarium material were what is now the Natural History Museum (BM) and Kew herbarium (K). Smaller numbers were distributed to other herbaria at various times, but do not impinge on the present discussion.

The Natural History Museum collections came from:

1. Material sent home by Cunningham during his contractual period (1814–1831) to Banks and, after his death, to Robert Brown.
2. Material sent to Aiton at Kew and housed there until 1840, when Robert Brown removed it to BM.
3. Possibly, small numbers donated by other botanists, who had received gifts from Cunningham or Heward.
4. A small number of specimens received from the Linnean Society of London.

Many Cunningham collections in BM were subsequently distributed to other herbaria, notably the Royal Botanic Gardens, Edinburgh (E), and to various Australian herbaria (particularly MEL and NSW).

The Kew collections came from:

1. The Bentham herbarium donated in 1854. Bentham had received these specimens via Richard Cunningham (before 1831), direct from Allan Cunningham (1831–1838), or from Heward after Cunningham's death.
2. The William Hooker herbarium purchased in 1866. Hooker had received these specimens while Professor of Botany at Glasgow, from Richard Cunningham (before 1831) or direct from Allan Cunningham (1831–1838).
3. The donation to Kew by Robert Heward in 1862 of specimens from Cunningham's bequest. These specimens represent Cunningham's personal herbarium, although Heward's large labels were written after Cunningham's death, and represent Heward's interpretation of provenance, taken from a (well-informed) reading of Cunningham's papers.
4. Possibly, small numbers donated by other botanists, who had received gifts from Cunningham or Heward.
5. A small number of Australian specimens received from the Linnean Society of London (but apparently not including Timor collections).

#### **The labels on the K and BM Cunningham specimens**

Cunningham's collections bear a bewildering array of labels, reflecting their passage through different hands, and can be a source of confusion. The list below reflects the kinds of labels which are found

on the collections from Timor in the two main repositories of Cunningham's collections from that island. Not all types are found on all sheets.

#### Natural History Museum (BM)

1. Cunningham's 'tickets'. These are Cunningham's own field labels, in his own hand, often consisting only of a number (that cited on a shipping list at the end of each expedition, in this case on his return to Sydney in 1818), or in other cases a brief note on locality, habitat or habit.
2. A small printed label stating collector, locality and date. These were produced curatorially in BM, as similar labels exist for other more or less contemporary collectors.
3. A small printed label 'Presented by the Linnean Society 1915'. Material formerly in the Linnean Society of London, and sent to BM via K.
4. Sometimes, one or more determination slips.

#### Royal Botanic Gardens, Kew (K)

1. Cunningham's 'tickets' as for BM.
2. Heward's handwritten label, indicating material distributed after Cunningham's death, but from his personal herbarium.
3. A printed label recording Heward's donation 'Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq., 1862'. This is sometimes altered in manuscript for extra-Australian material.
4. A printed label 'New Holland. A. Cunningham. Hooker 1835'. These date from Cunningham's period in London (1831–1836) and may mark a major donation of Cunningham material to Hooker. Cunningham distributed much of his herbarium to the botanists Lindley (Cambridge), Candolle (Geneva), Endlicher (Vienna), Schauer (Breslau), Fischer (St Petersberg), Martius (Munich), David Don, Ward and Bentham, and to some unnamed friends (Cunningham 1836) prior to his return to New South Wales.
5. A circular handstamp 'Herbarium Benthamianum 1854' indicating a specimen from Bentham's donation in that year.
6. A circular handstamp 'Herbarium Hookerianum 1867' indicating a specimen from Hooker's herbarium purchased in 1866.
7. Sometimes, one or more determination slips.

Printed Linnean Society labels have not been seen on Cunningham's Timor collections in K, although these are frequently encountered on his Australian collections.

#### The lists

Immediately upon his return to Sydney after the King voyages, Cunningham prepared lists of his seed and herbarium specimen collections, and sent these, with the material collected, to Aiton, with duplicate material for Banks separately packaged. Aiton (through Richard Cunningham) forwarded Banks' share to him in Soho Square immediately on arrival. The 'collecting numbers' that appear on Cunningham labels are actually these consignment list numbers, which appear to have been applied post-collection, just before despatch, as they are not always chronological. As both Banks and Aiton jealously guarded their 'rights' to Cunningham's seeds and specimens (and Cunningham was several

times admonished for not sending sufficient duplication, particularly of seed) it would be expected that material of all taxa listed in the consignment lists would be found in both K and BM. This is not so. The explanation probably lies in a combination of factors: material lost, destroyed or misfiled over the years, specimens on loan at the time we searched, material re-identified and refiled in one herbarium but not another, material that has lost its provenance labels over the years, material sent as exchange to other herbaria, etc.

Four shipping lists of Timor material have been discovered, one each of specimens from the 1818 and 1819 visits to Timor, and seed lists from 1818 and 1819. All sheets of Cunningham material from Timor found in K and BM are listed, following Cunningham's shipping list text. In those cases where no material was located, notes on the taxa searched are given. In searching for material we were guided by Cunningham's field determinations (which were surprisingly accurate at least at family level, and often to genus or even species). In addition the only complete flora of Timor, *Prodromus Flora Timorensis* by H.N. Ridley *et al.* (1885), provided a number of citations of Cunningham collections (most, unfortunately, lacking numbers), as well as a census of the main genera in the island, thus providing a starting point for manual searches.

Of taxa on the specimen lists, the majority have been found. Others probably still await rediscovery, but are of taxa quite different to those Cunningham thought he was collecting, and thus outside the scope of our search. Of the seeds, little can be said, except for those where a cross reference to a specimen was provided. The identity of the rest can mostly only be guessed at from the names listed in Ridley *et al.* (1885). Kew kept very poor records of the success or otherwise of the propagation material sent back by Cunningham. Only one Timor plant occurs among those illustrated by Bond and Duncanson (see Mabberley 2004) as new accessions to Kew: a plant identified as *Grislea* sp. (= *Woodfordia floribunda*), and described as 'Raised in 1820 from Seed collected at Timor by Mr Cunningham during the 2<sup>d</sup> voyage of Captain King. Seed Book 4062/1820'. This is No. 521 of the 1819 specimen list, and No. 288 of the seed list.

### 1818 Timor specimen list

This list comes from the Cunningham Papers, vol. 2: 3/1, ff. 24–26, housed in the Botany Library, Natural History Museum, London, and thus represents the copy sent to Banks. That sent to Aiton has not survived. The list was compiled by Cunningham in Sydney immediately following the conclusion of the voyage, and the numbers 307 to 339 are despatch numbers (interpolated into a much longer list of Australian plants collected before and after the Timor interlude) assigned to the specimens at random. They are not chronological, consecutive collecting numbers. The text is given as written by Cunningham, retaining his spelling, capitalisation and sentence structure. The names therefore are Cunningham's field determinations made in Timor and on his immediate return to Sydney. Where the notes are followed by a Latin diagnosis, this usually meant that Cunningham thought he had a previously undescribed taxon. The 'author citation' H.K. is Cunningham's shorthand for 'of Hortus Kewensis'. The numbers in brackets at the end of each entry are cross-references to his Seed List, in those cases where he also collected seed for the Royal Garden at Kew.

Following each entry is an enumeration of those specimens which have been located at the Natural History Museum, London (BM), and the Herbarium, Kew (K), along with the names they now bear, and a transcription of their labels. No Timor material has been located in other herbaria, but it may exist.

**307. Sapindi.** Tree of moderate size 20–25 feet high, leaves pinnate, fruit in racemes. Valleys and

deep-shaded Situat[ions] June.

**BM, K:** Not found (searched *Atalaya*, *Harpulia*, *Allophylus*, *Cardiospermum*, *Pometia*, *Cupania*, *Erioglossum*).

This is possibly *Schleichera oleosa* (Lour.) Oken, collected in 1819 as No. 524.

**308. Zizyphus Jujube.** A small Tree with spreading elongated branches, very frequent on the Sterile rocky Hills above Coepang.

**BM:** Not found (checked *Zizyphus*).

**K:** Filed as *Zizyphus jujube* Lam. Heward label 'Zizyphus jujube Lam., Coepang, Timor, A. Cunningham No. 308, June 1818', plus printed 'Allan Cunningham's Australian Collections, Presented by Robert Heward Esq., 1862', mounted with another collection by Horsfeld from Java (Herbarium Hookerianum).

**309. Bignonia (cymbicarpa) or perhaps B. indica.** Leaves bipinnate. A slender Tree 12–16 feet high. Sides of the Hills in rather shaded Situat<sup>ns</sup>. 9 June (104).

**BM:** Not found (checked *Oroxylum*, *Colea*, *Dolichandrone*, indets).

**K:** Not found (searched *Millingtonia*, *Dolichandrone*, *Colea*).

This may be *Millingtonia hortensis* L.f., collected also as No. 321.

**310. Gardenia sp.** (florida H.K?) A Shrub on the Margins of Fresh Water River, & sides of the Hills in its Vicinity near Coepang. 9 June (168).

**BM, K:** Not found (searched *Gardenia*, *Nauclea*, *Spermacoce*).

**311. Caesalpinia alata**, closely allied to C. Sappan Roxb. but differing in having a densely villous Calyx and a few scattered hairs on its foliage. Legume wing'd, a reclining prickly Shrub. Rocky Hills (150).

**BM, K:** Not found (searched *Caesalpinia*).

**312. Kleinhovia hospita.** A large Branching Tree. Valleys & sides of Rocky Hills. June (159).

**BM:** Not found (searched *Kleinhovia*).

**K:** Filed as *Kleinhovia hospita* L. Heward label 'Kleinhovia hospita Linn., Coepang, Timor, June 1818, A. Cunningham No. 312', and printed label 'Allan Cunningham's Australian Collection. Presented by Robert Heward Esq., 1862.'

**K:** Second sheet filed as *Kleinhovia hospita* L. Cunningham ticket 'Kleinhofia [sic] hospita L., Coepang, Timor', and handstamp 'Herbarium Hookerianum 1867'.

**313. Rubiaceae.** A small Tree in fruit, bacca 1-sperma. June (165).

**BM:** Filed as *Xylosma luzonense* (Presl) Clos. Cunningham ticket '313', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'. Det.: *Xylosma luzonense* (Presl) Clos, by Sleumer, 1954.

**K:** Filed as *Xylosma luzonense* (Presl) Clos. Cunningham ticket 'Rubiaceae, Coepang' plus handstamp 'Herbarium Hookerianum 1867' and Det.: *Xylosma luzonense* (Presl) Clos, H.Sleumer 11/53. Although unnumbered, this specimen is more likely to be this number than No. 530 of 1819, which Cunningham had field identified as 'Diospyros?'.

**314. Hesperidea, Guttiferae, Garcinia** with Polyadelphous flowers, Stamina numerous in fasciculi. Leaves of Calophyllum. A Tree of modest Size 40–50 feet, of beautiful aspect. Hills, Environs of Coepang, June, and on the sterile Shore of Port Hurd, Bathurst Island, N. Coast of Australia Lat. 11° 38' S, Long 130° 23' E. 27 May.

**BM:** Not found (searched *Garcinia*, *Mesua*).

**K:** Not found (searched *Garcinia*, *Calophyllum*, *Mesua*, *Kayea*, *Mamea*). The Bathurst Island collection was not located under Clusiaceae either, suggesting that Cunningham was mistaken in his identification of family.

**315. Pentandria Amaranthoideae.** A Shrubby reclining plant. Hills. June (167).

**BM:** Filed as *Deeringia amaranthoides* (Lamk.) Merr. Cunningham ticket '315', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid. June 1818'. Det.: *Deeringia amaranthoides* (Lamk.) Merr., A. Kanis, x.1975. (Figure 4, 5)

**K:** Filed as *Deeringia celosiooides* R.Br. No Cunningham tickets. Printed label 'New Holland. A. Cunningham. Hooker, 1835, with mss "Amaranthaceae, Timor Island" and handstamp "Herbarium Benthamianum 1854", mounted with another Timor specimen ex Herb. Mus. Paris 1836.

**316. Barleria Prionotes**, a thorny ornamental Plant, with preceding (167).

**BM:** Filed as *Barleria prionitis* L. Cunningham ticket '316', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'. Mounted with a Javanese specimen of the same species (Zollinger 626).

**K:** Filed as *Barleria tinctoria* [name not traced in IPNI]. Cunningham ticket '316 1 Voy.', and printed label 'Allan Cunningham's Australian Herbarium Presented by Robert Heward Esq. 1862', plus Heward mss label 'Barleria, Coepang, Timor, June 1818, A. Cunningham 316'. Mounted on type sheet of *Barleria tinctoria* with a specimen ex Herb. Paris, Timor (without collector or date) 'Recd 12/78'.

**317. Phyllanthoides**, baccate Shrub with elliptical obtuse alternate leaves & flowers in axillary clusters. Hills above the Town, June (157).

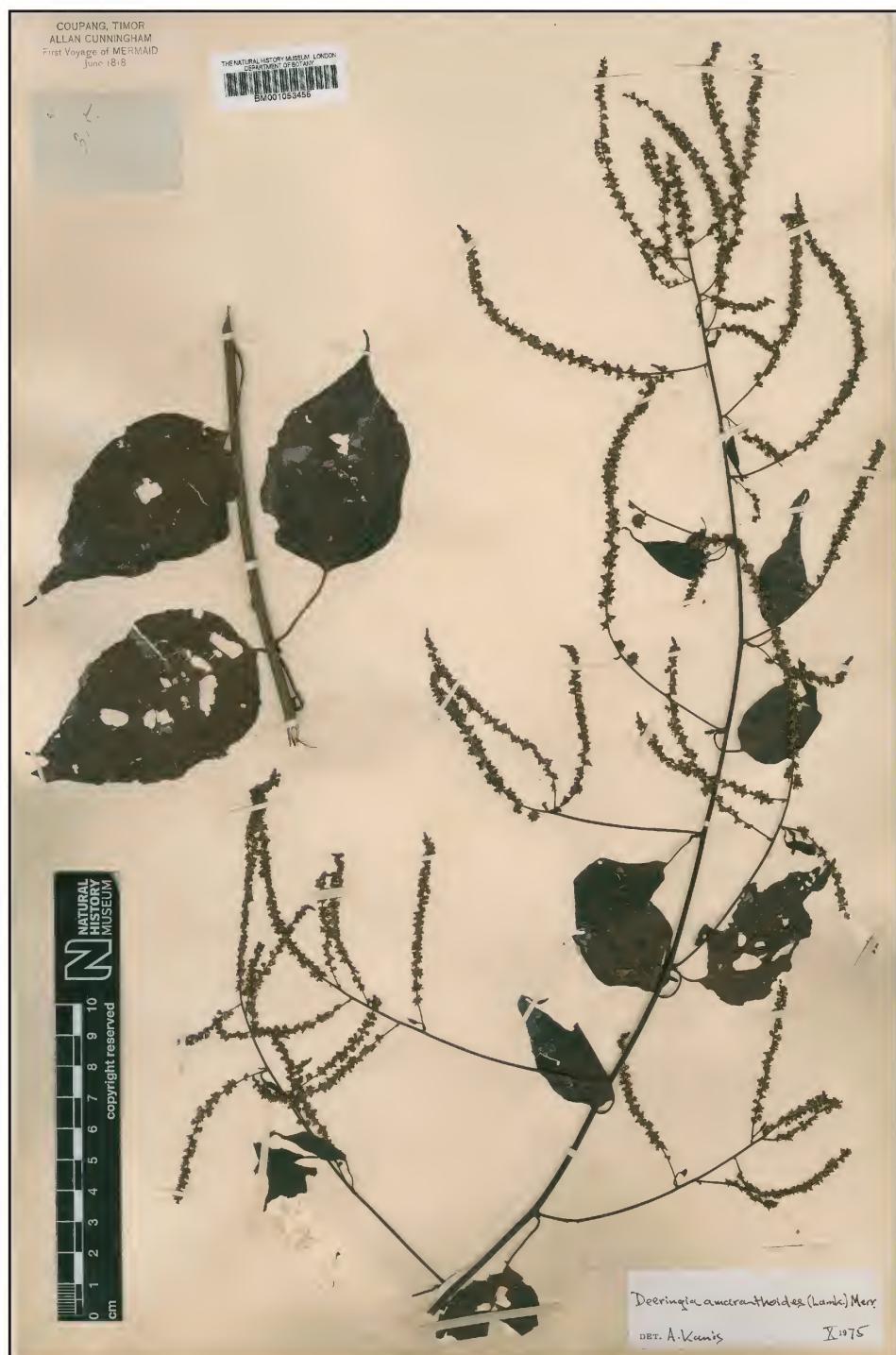
**BM:** Filed as *Phyllanthus* sp. indet. Cunningham ticket '317', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'. Det.: H.-J. Esser, May 2001 as *Phyllanthus*. This specimen was listed by Ridley *et al.* (1885) as *Breynia cernua*, but was excluded from *Breynia* by Esser.

**K:** Not found (searched *Phyllanthus*, *Breynia*).

**318. Cassia Sp.** foliis multijuga, foliolis ovato-oblongis, obtusis apice mucronatis, petiolis eglandulosis ramulisque fusco-tomentosis, racemis axillaribus terminalibus. A Slender Shrub 8 feet high. Sides of the Hills. In Thickets and dense Brushland. June.

**BM:** A group of 4 pods (mounted on a sheet with some Phillipines material collected by Reillo, 1912), of *Cassia timoriensis* DC., with a Heward label 'Cassia timoriensis, D.C. Coepang, Timor, June 1818, A. Cunningham. Pres<sup>t</sup>. by R. Heward, Esq., F.L.S.' and a printed label 'Presented by the Linnean Society, 1915'. (Figure 6)

**K:** Filed as *Cassia timoriensis* DC. Cunningham ticket '318, 1 Voy.', plus Heward label 'Cassia Timoriensis Dec. Coepang, Timor, June 1818, A. Cunningham 318', and printed label 'Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq. 1862'.

Figure 4. *Deeringia* specimen (No. 315) from Timor, 1818 (BM).

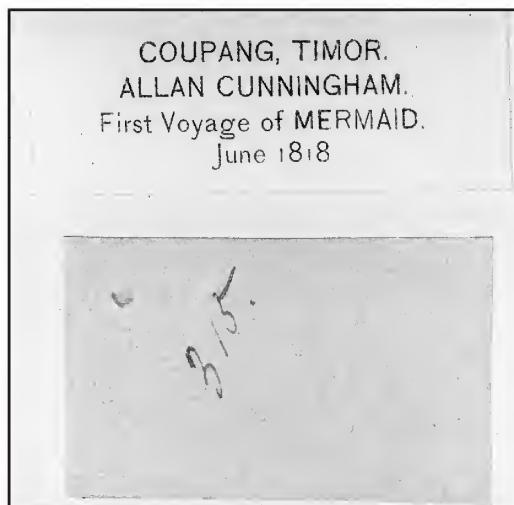


Figure 5. *Deeringia* specimen (No. 315) details of labels: printed BM label and Cunningham original '315' ticket (BM).

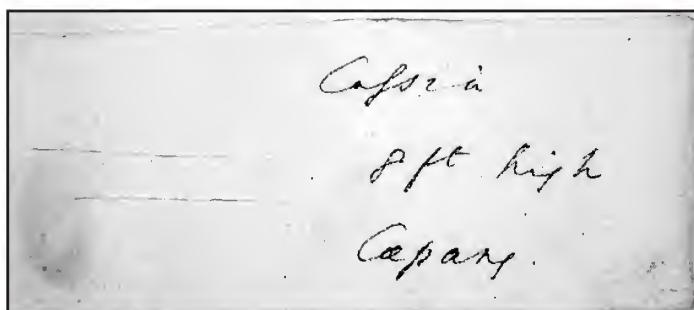


Figure 6. *Cassia timoriensis* sheet (No. 318), 1818, detail of label in Cunningham's writing (K).

**K:** Second sheet (leaves, flowers, young pods), filed under *Cassia timoriensis* DC. Cunningham ticket 'Cassia, 8 ft high, Coepang', and 'Herbarium Hookerianum 1867' handstamp.

**319. Loranthus sp.** pedunculis ternis geminina 3-partitis, floribus 4–5 andris, foliis ellipticis-oblongis. Parasitical on a Ficus. June 9.

**BM:** Filed as *Scurrula obovata* (Bl.) G.Don. Cunningham ticket '319', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'. Det.: *Scurrula obovata* (Bl.) G.Don by Danser, 1930.

**K:** Filed as *Scurrula obovata* (Bl.) G.Don. Cunningham ticket 'Loranthus, parasit. on Ficus, Timor.', handstamp 'Herbarium Hookerianum 1867', and Det.: *Scurrula obovata* (Bl.) G.Don by Danser, 1930.

**K:** Second sheet filed as *Scurrula obovata* (Bl.) G.Don. Printed label 'New Holland, A. Cunningham, Hooker 1835' with added ms 'Loranthus parasitic on Ficus, Timor Island' in an unknown hand, plus handstamp 'Herbarium Benthamianum 1854', and Det.: *Scurrula obovata* (Bl.) G.Don by Danser, 1930.

**K:** Third sheet filed as *Scurrula obovata* (Bl.) G.Don. Cunningham ticket 'Loranthus, parasit. on Ficus, Timor', Heward label 'Loranthus (on Ficus), Timor, June 1818, A. Cunningham No. 319', plus

printed 'Allan Cunningham's Australian Herbarium. Presented by Robert Heward Esq., 1862' and Det.: *Scurrula obovata* (Bl.) G.Don by Danser, 1930.

**320. *Nepeta* sp.** A Shrub of slender growth. Higher range of Barren Hills above Coepang. 9 June.

**BM:** Filed as *Sautiera decaisnii* Nees. Cunningham ticket '320', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'.

**K:** Not found in (searched *Sautiera*).

**321. *Bignonia* sp.** Foliis decompositis pinnatis foliolis ovatis acutis obliquis corymbis terminalibus. Strong volubilous plant. Hollow shaded damp Sitns, lands near Paddy Grounds &c, 9 June.

**BM:** Filed as *Millingtonia hortensis* L.f. Cunningham ticket '321', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'.

**K:** Filed as *Millingtonia hortensis* L. Cunningham ticket 'Bignonia, Coepang, Timor' and handstamp 'Herbarium Hookerianum 1867'.

**322. *Acacia* sp.** Leaves bipinnate branches aculeated, aculiae geminate, capitulum axillary, legumen round and same high. A Divaricate irregular rigid Shrub. Barren Rocky Hills. 9 June.

**BM:** Not found (searched *Acacia*).

**K:** Filed as *Acacia farnesiana* Willd. One sheet with two specimens, probably both from the same collection: Specimen A: Cunningham ticket '322, 1 Voy.', plus Heward label '236. *Acacia farnesiana* Willd., Coepang, Timor, June 1818, A. Cunningham 322', and printed label 'Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq. 1862'; Specimen B: Cunningham ticket 'Acacia, Coepang, Timor', and Herbarium Hookerianum 1867 handstamp. Det.: *Acacia farnesiana* (L.) Willd. by I. Nielsen, x.1982. (Figures 7–9)

**323. *Capparis* sp.** A shrub of low Stature. Roadsides. Old Walls. In barren rocky places in the Town of Coepang. June.

**BM:** Not found (searched whole family).

**K:** Filed as *Capparis spinosa* var. *marianna* (Jacq.) K.Schum. Cunningham ticket 'Capparis, Road sides, Old Walls, Coepang, Timor', plus Heward label 'Capparis, Coepang, Timor, A. Cunningham No. 323, June 1818.' and printed label 'Allan Cunningham's Australian Herbarium. Presented by Robert Heward Esq. 1862.' Mounted with a Riedel collection from the Malay Archipelago.

**324. *Banisteria timorensis, nova* sp.** Foliis cordatis acutis subtus glaucis, petiolis biglandulosis, umbellis axillaribus caule volubile. A twining plant. Hills about Coepang. 9 June. (150).

**BM:** Not found (checked *Rysopterys*, *Hiptage*).

**K:** Not found (searched *Rysopterys*, *Hiptage*, *Banisteriopsis*).

**325. Buttneriaceae [= Buttneriaceae].** Pentandria Pentag. Cal. 5-fidus campanulatiis. Cor. 5-petala. Caps. 5 angularis. A Shrub 5–10 feet high, allied to Commersonia. Sides of the Hills above the Town. 9 June.

**BM:** Not found (checked *Bytneria*, *Abroma*, *Melochia*, *Melhania*, *Grewia*, *Leptonychia*, *Commersonia*, *Asystasia*, *Andrographis*, *Waltheria*).

**K:** Not found (checked *Bytneria*, *Abroma*, *Melochia*, *Melhania*, *Commersonia*).



Figure 7. *Acacia farnesiana* sheet (No. 322), containing both a specimen ex Herbarium Hooker (lower) and the same ex Robert Heward (upper) (K).

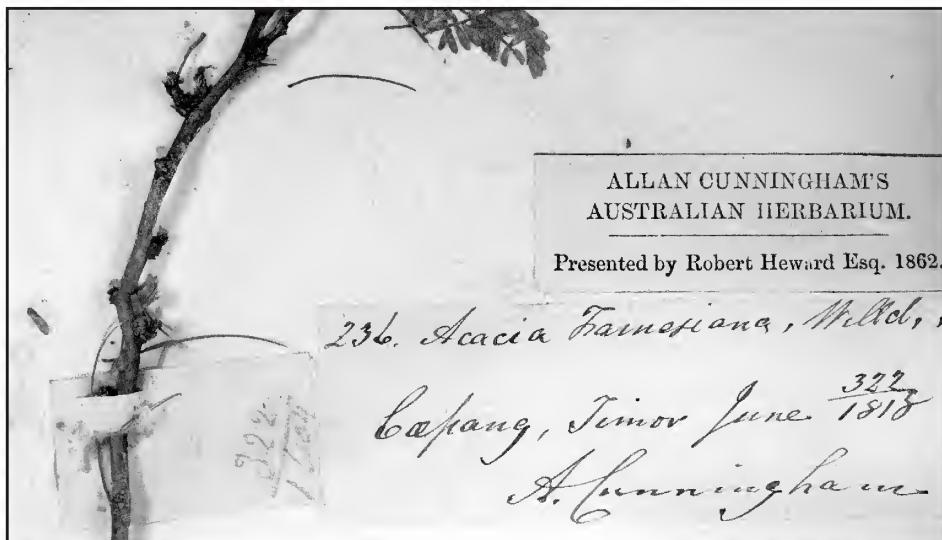


Figure 8. *Acacia farnesiana* specimen (No. 322), ex Heward, details of labels: printed Kew label; handwritten label by Heward (lower right); and original Cunningham '322 1st Voy.' ticket (K).



Figure 9. *Acacia farnesiana* specimen (No. 322), detail of Hooker herbarium circular stamp, and original Cunningham label (K).

**326. Helicteres Isora** – specimen in fruit, with preceding, 9 June (170).

**BM:** Not found (checked *Helicteres*).

**K:** Filed as *Helicteres isora* L. Heward label ‘*Helicteres Isora* Linn., Coepang, Timor, June 1818, A. Cunningham No. 326.’, and printed label ‘Allan Cunningham’s Australian Herbarium. Presented by Robert Heward Esq., 1862.’

**327. Malvaceae.** Caps. 3 locularis, sem. sericeus. Very frequent on the Hills in dry rocky situations. June.

**BM:** Filed as *Hibiscus* ‘near *micranthus*’. Cunningham ticket ‘327’, and printed label ‘Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818’.

**K:** Filed as *Hibiscus hirtus* L. Cunningham ticket ‘327, 1 Voy.’ plus Heward label ‘Coepang, Timor, A. Cunningham No. 327, June 1818’ and printed label ‘Allan Cunningham’s Herbarium, Presented by Robert Heward Esq. 1862’;

**K:** Second sheet, probably from same collection, filed as *Hibiscus hirtus*. Cunningham ticket ‘Sida, Malvaceae, Hills, Coepang, Timor’, plus ‘Herbarium Hookerianum 1867’ handstamp.

**328. Jasminum hirsutum** H.K. A twiggy round bushy plant. 7 June.

**BM:** Filed as *Jasminum pubescens* Willd. Cunningham ticket ‘328’, and printed label ‘Coupang Timor, Allan Cunningham, First Voyage of Mermaid, June 1818’.

**K:** Filed as *Jasminum multiflorum* (Burm.f.) Andrews. Cunningham tickets ‘328, Jasm. hirsutum, Coepang, Timor’, and ‘328 / 1 Voyage’, plus Heward label ‘*Jasminum pubescens* Willd. Coepang, Timor, June 1818, A. Cunningham 328’, printed ‘Allan Cunningham’s Australian Collections, Presented by Robert Heward Esq., 1862’, and ‘Herbarium Hookerianum 1867’ handstamp.

**329. Smilax sp.** A climbing shrub among Brushwood, (aculeated) Lower Hills. 9 June (174).

**BM:** Filed as *Smilax* sp. indet. Cunningham ticket ‘329’, and printed label ‘Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818’.

**K:** Filed as *Smilax* sp. Cunningham ticket ‘*Smilax* sp., Coepang, Timor’ and handstamp ‘Herbarium Hookerianum 1867’, plus Det.: ‘Prope Sm. bracteatum Presl. An eadem? Non *S. timorensis* Blume ined. ejus vidi spec.in h. Hörsfeld Mus. Par. Bl. visi. A.DC.’

**330. Sida sp.** Foliis subrotundo-cordatis in aequaliter dentatis acuminatis floribus paniculatis capsulis aristatis pedunculis multifloris caule fruticosus. Hills above the Town. June. (153).

**BM:** Filed as *Abutilon auritum* Don. Cunningham ticket ‘330’ plus mss A. Cunningham, Timor in unknown hand. Mounted with a C.W. Andrews collection from Christmas Island.

**K:** Filed as *Abutilon indicum* (L.) Sweet. Cunningham ticket ‘330, 1 Voy.’, plus Heward label ‘(Sida), Coepang, Timor, June 1818, A. Cunningham No. 330.’, printed label ‘Allan Cunningham’s Australian Herbarium. Presented by Robert Heward Esq., 1862.’, and Det.: *Abutilon indicum* (L.) Sweet prob. var. *australiensis* Hochr. by I. van Borssum Waakes, iii.1954.

**331. Dioecia.** Tree about 20 feet high, flowers in Terminal crowded corymbs, leaves large & angular. Habit of Aleurites. Rocky Hills. June.

**BM, K:** Not found. Possibly Euphorbiaceae?

**332. Echites sp.** Follicle fusiform, allied to *E. costata*. A strong irregular Shrub in low humid Sitns margins of Paddy Gardens. June 1818.

**BM:** Filed as *Anodendron paniculatum* A.DC. Cunningham ticket '332', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'. Det.: *Anodendron paniculatum* A.DC., by D. Middleton, 1994.

**K:** Not found (searched *Anodendron*).

**333. Casearia sp.** Flowers axillary [?decussate], leaves attenuated alternate, entire, margin undulated. A reclining arbuscula overhanging Paths & roadsides near Coepang. June.

**BM, K:** Not found (searched *Casearia*).

**334. Nerium sp. or Wrightia.** Follicles long united at the Base. Seeds compressed comose at their extremity. June A Small Tree 12–14 feet high. Shaded damp Situation. June.

**BM:** Filed as *Alstonia spectabilis* R.Br. Cunningham ticket '334', and printed label 'Coupang, Timor, Allan Cunningham, First Voyage of Mermaid, June 1818'. Det.: *Alstonia spectabilis* R.Br., by J. Monachino, 1947.

**K:** Filed as *Alstonia spectabilis* R.Br. Manuscript 'Timor, A. Cunningham' in an unknown hand, handstamp 'Herbarium Hookerianum, 1867', and Dets.: *Alstonia spectabilis* R.Br. by J. Monachino 1947 & K. Sidiyasa, 1996.

**K:** Second sheet filed as *Alstonia spectabilis* R.Br. Cunningham tickets '334, 1 Voy.' & 'Wrightia, Coepang, Timor', Heward label 'Wrightia pubescens? Coepang, Timor, June 1818, A. Cunningham 334', plus printed labels 'Allan Cunningham's Australian Herbarium Presented by Robert Heward Esq. 1862' and 'Flora Australiensis Named by Mr Bentham', handstamp 'Herbarium Hookerianum 1867' and Det.: *Alstonia spectabilis* R.Br. by J. Monachino 1947. Two pods and one branched twig on the sheet are marked as the elements received via Hooker, the balance apparently received directly by Kew from Heward.

**335. Varrovia sp.** An ornamental small Tree. Rocky Hills. June.

**BM:** Not found (searched *Cordia*).

**K:** Filed as *Cordia subpubescens* Decne. Cunningham ticket 'Cordia, Timor N-W-E.' and handstamp 'Herbarium Hookerianum 1867'. This seems to be a separate collection, but undated, of the same species collected as No. 519 on the 2<sup>nd</sup> Voyage (1819).

**336. Myrtaceae.** A tree of large Dimension, flowers axillary involucrated, leaves alternate. Rocky Shaded Moist places. Margins of Fr. Water River. June.

**BM:** Not found (searched *Eugenia*, *Acmena*, *Psidium*, *Decaspermum*, *Syzygium obovatum*, *S. timorianum*).

**K:** Not found (searched *Eugenia*, *Acmena*, *Psidium*, *Decaspermum*, *Syzygium*).

**337. Flemingia strobilifera.** A Shrub in dark shaded humid Woods on the elevated Grounds between the Hills. June.

**BM:** Not found (checked *Flemingia*, *Desmodium*, *Indigofera*, *Zornia*).

**K:** Filed as *Flemingia strobilifera* Ait. Heward label 'Flemingia strobilifera Ait., Coepang, Timor,

June 1818, A. Cunningham 337', plus printed label 'With Allan Cunningham's Herbarium, Presented by Robert Heward Esq. 1862'.

**K:** Second sheet filed as *Flemingia strobilifera* Ait. Cunningham ticket 'Flemingia strobilifera, Timor', with 'Herbarium Hookerianum 1867' handstamp. (Figure 10)

**338. Aspidium sp.** A Fern with the preceding. June.

**BM:** Not found.

**K** (549139): Filed as *Amphineuron opulentum* (Kaulf.) Holttum. 'Coepang, Timor. Herbarium Hookerianum 1867'. Det.: R.E. Holttum 1976.

**K** (539615): Second sheet, filed as *Amphineuron opulentum* (Kaulf.) Holttum. 'A. Cunningham 338, June 1818, Coepang, Timor'. Det.: R.E. Holttum 1976.

Note: neither of these sheets was located during our search, but they have subsequently appeared on the Kew website (without images). Full details of label type are not available.

**339. Pteris sp.** Frond pinnate lanceolate. Slender Fern on rocks in the Bed of Fresh Water River. Coepang, 9 June.

**BM, K:** Not found.

### 1818 Timor seed list

From the Cunningham Papers vol. 2: 3/2 f. 11 & 3/3 ff. 5–6, housed in the Botany Library, Natural History Museum, London. The numbers on the right are cross references to the specimen list.

Island of Timor, Environs of Coepang

Lat. 10° 08' 30" S & Long. 123° 35' 46" E

150. <i>Caesalpinia alata</i> .....	311
151. <i>Convolvulus</i> sp. leaves small, lanceolate, cordate	
152. <i>Clitoria</i> sp., leaves ternate, ovate, veined, volubilous	
153. <i>Sida</i> sp., Hills above Coepang [= <i>Abutilon</i> sp.] .....	330
154. <i>Kleinhovia Hospita</i> , Valleys & sides of the Hills [= <i>Kleinhovia hospita</i> L.].....	312
155. <i>Stizolobium pruriens</i> , a twining plant, with a legume densely covered with most painful urent setae	
156. <i>Banisteria timorensis</i> , a twining plant.....	324
157. <i>Phyllanthoides baccata</i> . A shrub frequent on the rocky Hills, flowers inaxillary clusters [= <i>Phyllanthus</i> sp.].....	317
158. <i>Diadelphia Psoralioides</i> . Legumen 1-spermum, folia terna	
159. <i>Cytisus Cajan?</i> plant dead	
160. <i>Cassia</i> sp., foliis multijugis, in Thickets & Dense brushwood [= <i>Cassia timorensis</i> DC.]....	318
161. <i>Cardiospermum Halicacabum</i>	
162. <i>Strychnos nux vomica?</i>	
163. <i>Cassia</i> sp., arbuscula scandens, foliis pinnatis ternatis	
164. <i>Bignonia</i> sp. (cymbicarpa) or perhaps <i>B. indica</i> Willd. [= <i>Millingtonia hortensis</i> L.f.].....	309

165. Rubiaceae, Bacca 1-sperma, supera, a small Tree [= <i>Xylosma luzonense</i> (Presl) Clos].....	313
166. Zizyphus Jujube [= <i>Zizyphus jujube</i> Lam.].....	308
167. Barleria Prionotis [= <i>Barleria</i> sp.] .....	316
168. Gardenia (florida?).....	310
169. Celosia (argentea)	
170. Helicteres Isora [= <i>Helicteres isora</i> L.] .....	326
171. Erythrina indica, a deciduous Tree abund <sup>t</sup> about the Environs of Coepang	
172. Cucurbitaceae. Cucurbita sp.	
173. Convolvulus sp. floral bracteae involucriform	
174. Smilax sp., a Scandent aculeated shrub	
175. Carobinea sp. Arbor grandis, foliis septimis, fructus 2-valvis, obovatis, polyspermis. N.B. The capsules when ripe are bright red Colour, & contain 8 seeds which when divested of their arillae are esculent but oily.	
176. Solanum sp.. Orange berries, aculeated	
177. Mimosa. Acacia sp, Legumen cylindrical. Inga? A Thorny Shrub with bipinnate leaves [= <i>Vachellia farnesiana</i> (L.) Wight & Arn.].....	322
178. Cucurbitaceae. Cucumis sp., fruit ovate	
179. Cathartocarpus sp. A Slender Tree in fruit, Legumen cylindrical, 12–16 feet high. Ranges of Hills above Coepang.	

### 1819 Timor specimen list

From the Cunningham Papers vol. 2: 5/1 ff. 36, 37, housed in the Botany Library, Natural History Museum. Conventions are as in the 1818 list. The names are Cunningham's field determinations made in Timor and on his immediate return to Sydney. The numbers in brackets at the end of each entry are cross-references to his seed list, in those cases where he also collected seed for the Royal Garden at Kew. Following each entry is an enumeration of those specimens which have been located at the Natural History Museum, London (BM), and the Herbarium, Kew (K), along with the names they now bear and a transcription of their labels. No Timor material has been located in other herbaria, but it may exist.

**513. Hypoestes sp.** – Justicia allied to bivalvis – imperfect Specm. Dry Rocky Hills, Novr.

**BM:** Not found (checked *Dicliptera*, *Strobilanthes*, *Hypoestes*, *Justicia*, *Ruellia*, *Dipteracanthos*).

**K:** Filed as *Dicliptera armata* F.Muell. Cunningham tickets '513, 2 V.' and 'Hypoestes. Timor' plus Heward label 'Dicliptera glabra Decaisne, Coepang, Timor, A. Cunningham 513, 1819', plus printed label 'Allan Cunningham's Australian Herbarium. Presented by Robert Heward Esq. 1862.' Dets.: *Dicliptera glabra* Decaisne, by C.B. Clarke, 8 July 1905 and *Dicliptera armata* F.Muell., by K. Ballenall, 08/07/1993.

**514. Rubiaceae. Mussaenda sp. frondosa.** A rigid stiff plant on the Hills (283).

**BM:** Filed as *Canthopsis pubiflora* Miq. at. Cunningham ticket '514', and printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819'.

**K:** Filed as *Catunaregam* sp. [?pubiflora]. Cunningham ticket 'Mussaenda frondosa, Timor', plus handstamp 'Herbarium Hookerianum 1867'.



Figure 10. *Flemingia strobilifera* specimen (No. 337), 1818, ex Herbarium Hooker (K).

**515. *Cynanchum* sp.** caule volubilis fruticosa, foliis cordata apice attenuatis, obtusis, Umbellis congestis pedunculatis. In thickets on the Hills.

**BM:** Filed as *Tylophora* sp. indet. Cunningham ticket '515', and printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819'. Also an unsigned drawing of a dissection of the flower, and notes.

**K:** Not found (searched *Tylophora*, *Cynanchium*, *Marsdenia*, *Periploca*).

**516. *Periploca mauritiana*?** A volubilous shrub, with preceding.

**BM:** Not found (searched *Marsdenia*, *Hoya*, *Discidia*, *Gymnema*, *Dregea*, *Cryptolepis*, *Pergularia*, *Periploca*, *Secamone*, *Calotropis*, *Ceropegia*).

**K:** Not found (searched *Tylophora*, *Cynanchium*, *Marsdenia*, *Periploca*).

**517. *Carissa* sp.,** distinct from spinosum, vide Rumph. amb. Hills.

**BM, K:** Not found (searched *Carissa*).

**518. *Tabernaemontana coronaria* viz. in H.K. an ornamental Shrub on the Hills.**

**BM:** Filed as *Tabernaemontana pandacaqui* Lam. Cunningham ticket '518', and printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819'. Det.: *Ervatania decaisnei* A.DC., conforms to Paris type, Boiteau, 1976; *Tabernaemontana pandacaqui* Lam., A.J.M. Leeuwenberg 1988.

**K:** Not found (searched *Tabernaemontana*).

**519. *Cordia* sp. allied to *monoica* Roxb.** Freqt on the Hills. (284).

**BM:** Filed as *Cordia subpubescens* Decne. Cunningham ticket '519', and printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819.'

**K:** Filed as *Cordia subpubescens* in Type folder for *C. subpubescens*. Cunningham ticket '519/2', with Heward label 'Coepang, Timor, A. Cunningham No. 519, Nov. 1819', and printed label 'Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq., 1862', and 'Herbarium Hookerianum 1867' handstamp. Mounted with a second Timor collection, without collector, ex Herb. Paris 1836, ex Herb. Benthham 1854.

**K:** Filed in Type folder of *Cordia subpubescens*, Timor, without collector, ex Herb. Paris, recd 12/78.

**K:** Filed as *Cordia subpubescens*. Cunningham ticket 'Cordia, Timor', with 'Herbarium Hookerianum 1867' handstamp.

**520. *Vitis* sp.,** a large scandent plant at this period without leaves, shaded thickets.

**BM:** Not found (checked *Leea*, *Cissus*, *Vitis*).

**K:** Not found (checked *Leea*, *Cissus*, *Vitis*, *Cayratia*, *Parthenocissus*, *Ampellocissus*, *Nothocissus*, *Pterisanthes*, *Tetrastigma*, Vitaceae indet.).

**521. *Grislea tomentosa* Roxb.** a large twiggy Shrub, Rocky Hills.

**BM:** Filed as *Woodfordia floribunda* Salisb. Typed label 'Timor, 1819, Allan Cunningham 521'.

**BM:** Second sheet filed as *Woodfordia floribunda*, bearing just Cunningham's ticket '521', and pencilled annotation 'Timor. Allan Cunningham, 1819, Grislea tomentosa Roxb.'

**K:** Not found (searched *Woodfordia*).

**522. Amyris sp. aculeata**, foliis ternatis, foliolis ellipticis, undulatis, integerrima apice attenuatis subtus petiolis ramulisque tomentosis, racemis axillaribus folio brevioribus. A shrub frequent on the Hills. Novr. (289). [The Latin diagnosis indicates that Cunningham thought that this was a previously undescribed species].

**BM:** Not found (checked *Zanthoxylon*, *Euodia*, *Micromelum*, *Triphasia*, *Glycosmis*, *Murraya* (*Chalcas*), *Clausena*, *Citrus*).

**K:** Not found (checked *Zanthoxylon*, *Euodia*, *Micromelum*, *Citrus*, *Triphasia*, *Glycosmis*, *Murraya*, *Clausena*).

**523. Amyris sp. allied to A. dentata Willd** – villosa, foliis pinnatis foliolis ovato-lanceolatis serratis, apice attenuatis integris, racemis axillaribus elongatis. A shrub, among Brushwood, on the Hills.

**BM, K:** Not found (as above). It seems likely that Nos 522 and 523 were misidentified by Cunningham as to family.

**524. Mimusops sp. Achras** – Bacca 1–2 sperma (What is Achras dissecta Forst?) A Tree 20 feet of branching habit. Hills above Coepang.

**BM:** Filed as *Schleichera oleosa* (Lour.) Oken. Cunningham ticket '524' and mss 'Timor, A. Cunningham, 1819' in an unknown hand. Det.: *Schleichera oleosa* (Lour.) Oken by P.W. Leenhouts, 1969.

**K:** Filed as *Schleichera oleosa* (Lour.) Oken. Heward label 'Hills above Coepang, Timor, Novr 1819, A. Cunningham No. 524' plus printed label 'Allan Cunningham's Australian Herbarium. Presented by Robert Heward Esq., 1862', and Det.: *Schleichera oleosa* (Lour.) Oken by P.W. Leenhouts, 1969.

**K:** Second sheet filed as *Schleichera oleosa* (Lour.) Oken. Cunningham ticket 'Mimusops or Achras, Timor', plus Det.: *Schleichera oleosa* (Lour.) Oken by P.W. Leenhouts, 1969.

**525. Lawsonia spinosa Linn.** a var. of *inermis* vide Desfont. atlant. p. 325, with the preceeding (290).

**BM:** Not found (checked *Lawsonia*).

**K:** Filed as *Lawsonia spinosa* L. Cunningham ticket 'Lawsonia spinosa, Timor' in Cunningham's hand.

**526. Vitex latifolia lamarck.** A Tree 25 feet high, of branching ornamental regular Habit. Hill above the Town. (297).

**BM (757587):** Filed as *Vitex parviflora* A.Juss. Typed label 'Coupang, November 1–9, 1819, Coll. A. Cunningham No. 526, 2nd. Voyage of "Mermaid"'. Det.: *Vitex parviflora* A.Juss. by R.P.J. de Kok, 2003.

**BM (757588):** Second sheet filed as *Vitex parviflora* A.Juss. Cunningham ticket '526', printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819', and Det.: *Vitex parviflora* A.Juss., by R.P.G. de Kok, 2003.

**K (698692):** Filed as *Vitex parviflora* A.Juss. Cunningham ticket 'Vitex latifolia, Timor'. 'Herbarium Hookerianum 1867' handstamp. Det.: *Vitex parviflora* A.Juss. by R.P.J. de Kok, 2003.

**527. Ruellia sp.** humifusa, villosa fruticosa, foliis ovatis acutis, sessilibus nervosis capitulis terminalibus involucratis lanuginosis. A Shrubby plant growing in Tufts, observed frequent in the Rice grounds, occasionally inundated. Vic<sup>y</sup> of Coepang.

**BM:** Filed as *Lepidagathis humifusa* Decne. Cunningham ticket '527', plus printed label 'Coupang, Timor. Allan Cunningham. Second Voyage of Mermaid, Nov. 1–9, 1819'.

**K:** Filed as *Lepidagathis humifusa* Decne. Cunningham ticket 'Ruellia humifusa, Timor', plus Heward label 'Lepidagathis Decaisne (Ruellia) humifusa A.C. MSS, Coepang, Timor, A. Cunningham 527, Nov. 1819', and printed label 'Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq. 1862'. Second label with '527/1819, Timor' in Cunningham's hand, plus 'Ruellia sp. humifusa' in another hand. Handstamp 'Herbarium Hookerianum 1867'. Det.: *Lepidagathis humifusa* Decaisne by C.B. Clarke, 8 May 1905.

**528. Sterculia sp. allied to S. macrophylla of Vent.** A Tree of low stature, but robust & stately growth. Barren Hills (304).

**BM:** Filed as *Sterculia* sp. indet. Manuscript 'Insula Timor, prope Coepang, Cunningham in King's 3rd Voyage, No. 528' on reverse.

**BM:** Second sheet filed as *Sterculia populifolia* DC. Handwritten label (unknown hand, possibly Richard Cunningham) 'Sterculia populifolia De Cand. prodr. exclus. syn Roxb. Timor, Allan Cunningham, cfr. St. 4fidum et urceolatam'.

**K:** Filed as *Sterculia populifolia* DC. Cunningham ticket '528/2nd Voy.', plus Heward label 'Sterculia, Coepang, Timor, A. Cunningham No. 528, Nov. 1819', and printed label 'With Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq., 1862'. Det.: *Sterculia ceramica* R.Br. by W. Soegeng Riksodihargo, 1964 & for *Sterculia populifolia* DC. by I.G.M. Tantra, 26/8/1975.

**529. Croton sp.**, scabra tomentosa foliis subrotunda cordatis acutis nervosis, subcrenulato-undulata glandulosis, racemis elongatis axillaribus terminalibus. To be examined with the Linnean *C. moluccanum* (an *Aleurites*). Shrub on the Hills. [The Latin diagnosis indicates that Cunningham thought that this was a previously undescribed species].

**BM:** Filed as *Mallotus papillaris* (Blanco) Merr. Cunningham ticket '529' and printed label 'Coupang, Timor. Allan Cunningham. Second Voyage of Mermaid, Nov. 1–9, 1819'. Det.: *Mallotus papillaris* (Blanco) Merr. by Soraya Sierra, 14 April 2005.

**K:** Filed as *Mallotus papillaris* (Blanco) Merr. Cunningham ticket '529, 2', plus Heward label 'Croton, Timor, A. Cunningham No. 529, Nov<sup>r</sup> 1819' and printed label 'Allan Cunningham's Australian Herbarium, Presented by Robert Heward Esq, 1862'. Det.: *Mallotus papillaris* (Blanco) Merr. by Soraya Sierra, 14 April 2005.

**K:** Second sheet filed as *Mallotus papillaris* (Blanco) Merr.. Cunningham ticket 'Croton, Timor', and handstamp 'Herbarium Hookerianum 1867'. Det.: *Mallotus papillaris* (Blanco) Merr. by Soraya Sierra, 14 April 2005.

**530. Ebenaceae? Diospyros?** glabra, foliis elliptico-ovatis attenuatis, undulato-repandis, axillis foliorum spinosis, racemis axillaribus congestis. Rocky Hills in the Vicinity.

**BM:** Filed as *Xylosma luzonense* (Presl) Clos. Cunningham ticket '530', and printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819'. Det.: *Xylosma*, by Merrie, 1935 and *Xylosma luzonense* (Presl) Clos, by H. Sleumer, 11/1953. Probably a second (re-)collection of No. 313 (1818).

**K:** Filed as *Xylosma luzonense* (Presl) Clos. Cunningham ticket '530, 2d', plus Heward label 'Coepang, Timor, A. Cunningham No. 530, Nov. 1819, Pres<sup>d</sup> by Mr Heward 1862', and a Det.: *Xylosma luzonense* (Presl) Clos, H. Sleumer 11/1953.

**K:** Second specimen filed as *Xylosma luzonense* (Presl) Clos. Cunningham ticket 'Ebenaceae, Timor', plus handstamp 'Herbarium Hookerianum 1867', and Det.: *Xylosma luzonense* (Presl) Clos, H. Sleumer, 11/1953.

**531. *Ficus* sp.** nearly related to *benamina* & *comosa* of Roxb. A large Tree, having the stem densely matted with the roots that proceed as well from the branches as from the Trunk itself. These roots descend & on reaching the Ground, penetrate immediately beneath the Surface. Woods in Vicinity Margins of flats converted in Rice Grounds. Nov. 1819.

**BM:** Filed as *Ficus lacor* Ham. Cunningham ticket '531', and printed label 'Coupang, Timor, Allan Cunningham, Second Voyage of Mermaid, Nov. 1–9, 1819'. Det.: *Ficus lacor* Ham., E.J.H. Corner, 2/1986.

**K:** Filed as *Ficus virens* Ait. Cunningham ticket 'Ficus, Timor' with a triangle enclosing a small circle, and handstamp 'Herbarium Hookerianum 1867'. Also a label 'Urostigma ? timorense Miq.' and a similar handstamp, plus Det.: *Ficus virens* Ait., E.J.H. Corner, x/1958.

### 1819 Timor Seed List

The numbers in this list continue from those of the north-west coast of Australia visited by King and Cunningham immediately beforehand, and are followed by seeds from the vicinity of Sydney, collected at the conclusion of the voyage. The numbers on the right are cross references to the specimen list.

#### Specm List

- |   |     |
|---|-----|
| 280. <i>Jasminum pubescens</i> [possibly <i>Jasminum multiflorum</i> (Burm.f.) Andrews]   |     |
| 281. <i>Convolvulus</i> sp. (plant dead)  |     |
| 282. <i>Solanum</i> sp. aculeated Shrub, fruit large yellow. [possibly <i>S. ferox</i> L. or <i>S. lasiocarpum</i> Dunal]   |     |
| 283. <i>Mussaenda frondosa</i> [= <i>Catunaregam</i> sp.] .....   | 514 |
| 284. <i>Cordia monoica?</i> Roxb. [= <i>Cordia subpubescens</i> Dcne].....  | 519 |
| 285. <i>Zizyphus Jujube</i> [probably <i>Ziziphus jujube</i> (L.) Gaertn. / <i>Z. mauritiana</i> Lam.]  |     |
| 286. <i>Calotropis gigantea</i> Br.   |     |
| 287. <i>Wrightia antidysenterica</i> [probably <i>Alstonia spectabilis</i> R.Br.]   |     |
| 288. <i>Grislea tomentosa</i> Roxb. (Woodfordia Andr.) (Lythrum Linne)<br>[= <i>Woodfordia floribunda</i> Salisb.].....   | 521 |
| 289. <i>Amyris aculeata</i> .....   | 522 |
| 290. <i>Lawsonia spinosa</i> Linn. [= <i>Lawsonia spinosa</i> L.] .....   | 525 |
| 291. <i>Sapind?</i> <i>Arbuscula</i> 12–16 pedata, folia pinnata. Capsule elongata siliquiformis, 1-locularis, 3-valvis polyformata. Sem. [unreadable] 3-alata as in <i>Paullinia</i> . |     |
| 292. <i>Cathartocarpus Fistula</i> [ <i>Cassia fistula</i> L.]  |     |
| 293. <i>Cathartocarpus javanica</i> [possibly <i>Cassia javanica</i> L.]  |     |
| 294. <i>Caesalpinia alata</i> [probably not <i>Caesalpinia</i> sp.]   |     |
| 295. <i>Gartnera racemosa?</i> ( <i>Banisterioides</i> )  |     |

296. Crateva sp. 7 fruit, arbuscula, folia ternata	
297. Vitex latifolia Lamarck [= <i>Vitex parviflora</i> Juss.]	526
298. Passiflora sp. folia quinquepartita (plant dead)	
299. Hibiscus sp. narrow pentagonal capsule (dead) [probably <i>Hibiscus hirtus</i> L.]	
300. Erythrina Corallodendron or indica? (flowering plant not seen)	
301. Stizolobium pruriens Persoon [= <i>Mucuna pruriens</i> (L.) DC.]	
302. Flemingia strobilifera Brown in H. K. vol. 4 [= <i>Flemingia strobilifera</i> (L.) R.Br.]	
303. Aristolochia indica (a few seeds)	
304. Sterculia sp. distinct from S. macrophyllum of Vent., a native of Java [= <i>Sterculia populifolia</i> DC.]	528
305. Cucurbita sp. a dry Gourd, frequent in thicket	
306. Phyllanthoides baccata allied to Flueggia of Willd. ( <i>Cluytia</i> ?) [= <i>Phyllanthus</i> sp.]	
307. Inga sp., an aculeated tall Shrub, frequent on the Hills [probably not <i>Inga</i> ]	
308. Acacia sp., a thorny tall plant, leaves pinnated [= <i>Vachellia farnesiana</i> (L.) Wight & Arn.]	
309. Frutex folia glabra, bacca 3-sperma, seminibus compressis	
310. Gentianeae? a tall slender plant, dead. Rocky Hills, Coepang	
311. Octandria Tetragynia, Caps 5-locularis polysperma	

### Acknowledgements

We gratefully acknowledge painstaking and friendly assistance in our Cunningham research from the herbarium, library and archives staff of both the Botany Department, Natural History Museum, and Royal Botanic Gardens, Kew. John Hunnex (Natural History Museum) kindly prepared quality scans of a number of BM specimens. Ben Sherwood, former Librarian of the Linnean Society of London, and colleagues, materially assisted us in searching Linnean Society Council Minutes for records of the ex-Linnean Society material. We also thank the then-Keeper of the Herbarium, Kew, Dr David Mabberley, for providing us with office facilities during the tenure by one of us (AEO) of the position of Australian Botanical Liaison Officer at Kew (August 2008 – October 2009) and again during private visits (March–June 2011), and May–June 2012. This support greatly facilitated our research efforts. The work was supported in part by a grant from the Australian Biological Resources Study, while AEO was ABLO at Kew. Annette Wilson (ABRS) provided comments on an early draft of this paper, assisted in preparation of the illustrations, and drew our attention to the ex-Linnean Society specimen in CANB.

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***Cochlospermum macnamarae* (Bixaceae), a rare, new endemic from the Pilbara bioregion of Western Australia****Michael Hislop<sup>1,3</sup>, Kevin R. Thiele<sup>1</sup> and Daniel Brassington<sup>2</sup>**<sup>1</sup>Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983<sup>2</sup>Western Botanical, Landcare Holdings Pty Ltd,  
19 McDonald Crescent, Bassendean, Western Australia 6054<sup>3</sup>Corresponding author, email: Michael.Hislop@dec.wa.gov.au**Abstract**

Hislop, M., Thiele, K.R. & Brassington, D. *Cochlospermum macnamarae* (Bixaceae), a rare, new endemic from the Pilbara bioregion of Western Australia. *Nuytsia* 23: 89–94 (2013). A new species of *Cochlospermum* Kunth, *C. macnamarae* Hislop, K.R.Thiele & Brassington, is described, illustrated and mapped. It occurs in the semi-arid Pilbara bioregion of Western Australia, unlike the other Australian species which all occur in the wet-dry tropics. A revised key to the genus in Australia is provided to accommodate the new species.

**Introduction**

The taxonomy of the Australian members of the pantropical genus *Cochlospermum* Kunth has changed little since Bentham's treatment in *Flora Australiensis* (1863). Indeed it was Bentham who described the last new species for Australia, *C. gillivraei* Benth. The four species recognised in that treatment became three when Poppendieck (1980) reduced *C. heteronemum* F.Muell. to a subspecies of *C. fraseri* Planch. This change was accepted by George (1982) in his account of the genus for the *Flora of Australia*. The most recent and best-illustrated treatment of the genus appears in the *Flora of the Darwin region* (Kerrigan & Dixon 2011). Before the discovery of the new species described in this paper, *Cochlospermum* had been represented in Western Australia by just one species, the widespread *C. fraseri* which occurs from the Kimberley Botanical Province to far north-western Queensland.

In September 2011 while engaged in a flora survey for a rail easement, members of Western Botanical environmental consultancy made collections of a *Cochlospermum* from a remote part of the Pilbara bioregion (Department of the Environment, Water, Heritage and the Arts 2008). A preliminary investigation soon revealed that a significant botanical discovery had been made. Not only was it the first record of the genus for the Pilbara bioregion, but it quickly became apparent that the collections were not referable to *C. fraseri*. Although as currently understood *C. fraseri* is morphologically variable, the small flowers and especially the small, very deeply lobed leaves of the Pilbara plants did not match any of the variation documented for that species. Of the other two Australian members of the genus, *C. gregorii* F.Muell. and *C. gillivraei* (both of which occur widely in the Top End of the Northern Territory and the Gulf Country and Cape York Peninsula in Queensland), the latter was most similar to the Pilbara plants. Comparisons with that species have shown that the new species can always be distinguished by its smaller leaves with significantly narrower lobes, and smaller flowers.

Species of *Cochlospermum* differ mainly in quantitative features, particularly in the nature and proportions of leaf lobing, rather than in qualitative floral or fruiting features. In this context, and given the geographical and ecological disjunction, we believe that the degree of morphological distinction is consistent with the recognition of a new species, which is described herein as *C. macnamarae* Hislop, K.R.Thiele & Brassington.

## Methods

The description of the new species is based on examination of *Cochlospermum* collections housed at PERTH and of specimens of *C. gillivraei* and *C. gregorii* loaned from CANB. Additional measurements of specimens of *C. gillivraei* housed at DNA were made by Ian Cowie. Foliar measurements were taken from dried specimens, and floral measurements from rehydrated flowers.

## Taxonomy

### ***Cochlospermum macnamarae* Hislop, K.R.Thiele & Brassington, sp. nov.**

*Typus*: c. 180 km north-west of Newman, Western Australia [precise locality withheld for conservation reasons], 30 September 2011, D. Brassington, E. Ager & J. Macknay LCH 31756 (*holo*: PERTH 08330026; *iso*: CANB).

*Cochlospermum* sp. Pilbara (D. Brassington, E. Ager & J. Macknay LCH 31756), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 15 February 2013].

Spreading, multi-stemmed shrubs to c. 2 m high and 3 m wide, from a robust (possibly fire-tolerant) rootstock. Young stems glabrous, shiny, copper-brown, becoming grey and ± fissured with age. Stipules subulate, caducous, 3–4 mm long, glabrous or with a few glandular hairs about the margins. Petioles 35–70 mm long, glabrous but with a scurfy excrescence towards the base. Lamina palmatifid, 5–7-lobed, divided for 3/4–7/8 of its length, 50–80 mm long, 55–105 mm wide, glabrous; base cordate; lobes ± linear, very narrowly ovate or very narrowly elliptic, 20–55 mm long, 4–10 mm wide with length: width ratio 5.2–8: 1, acute or acuminate, the margins entire or with one or two coarse teeth. Inflorescence a terminal panicle to c. 80 mm long, mostly glabrous but usually with some irregular, glandular hairs at the nodes; bracts caducous, ovate or broadly ovate, 3–5 mm long, 2–3 mm wide, mostly with a few glandular hairs about the margins. Sepals ovate or broadly ovate, glabrous except the margins ciliolate with glandular hairs; outer sepals 11–13 mm long, 6.5–8.5 mm wide, obtuse; inner sepals 12–16 mm long, 8.5–10 mm wide, ± emarginate with a short, excentric, recurved mucro. Petals yellow, obovate, emarginate, 22–27 mm long, 13–15 mm wide. Stamens multiseriate, dimorphic, the outer whorl with longer, thicker filaments and larger anthers than the four inner whorls; outer filaments red, 9–10 mm long, c. 0.7 mm wide; outer anthers 3.2–3.3 mm long, 0.8–0.9 mm wide, the apical pore 0.4–0.45 mm diam.; inner filaments yellow, 4.5–5 mm long, c. 0.2 mm wide; inner anthers 2.3–2.7 mm long, 0.5–0.6 mm wide, the apical pore 0.3–0.35 mm diam. Ovary depressed-globose, 2.5–3 mm diam.; style sigmoid, 15–18 mm long. Capsule pendant, ovoid, c. 50 mm long and 30 mm wide; mature seeds not seen. (Figure 1)

*Diagnostic characters*. The new species can be distinguished from other Australian species by its shrubby habit, very deeply and narrowly lobed leaves and small flowers.

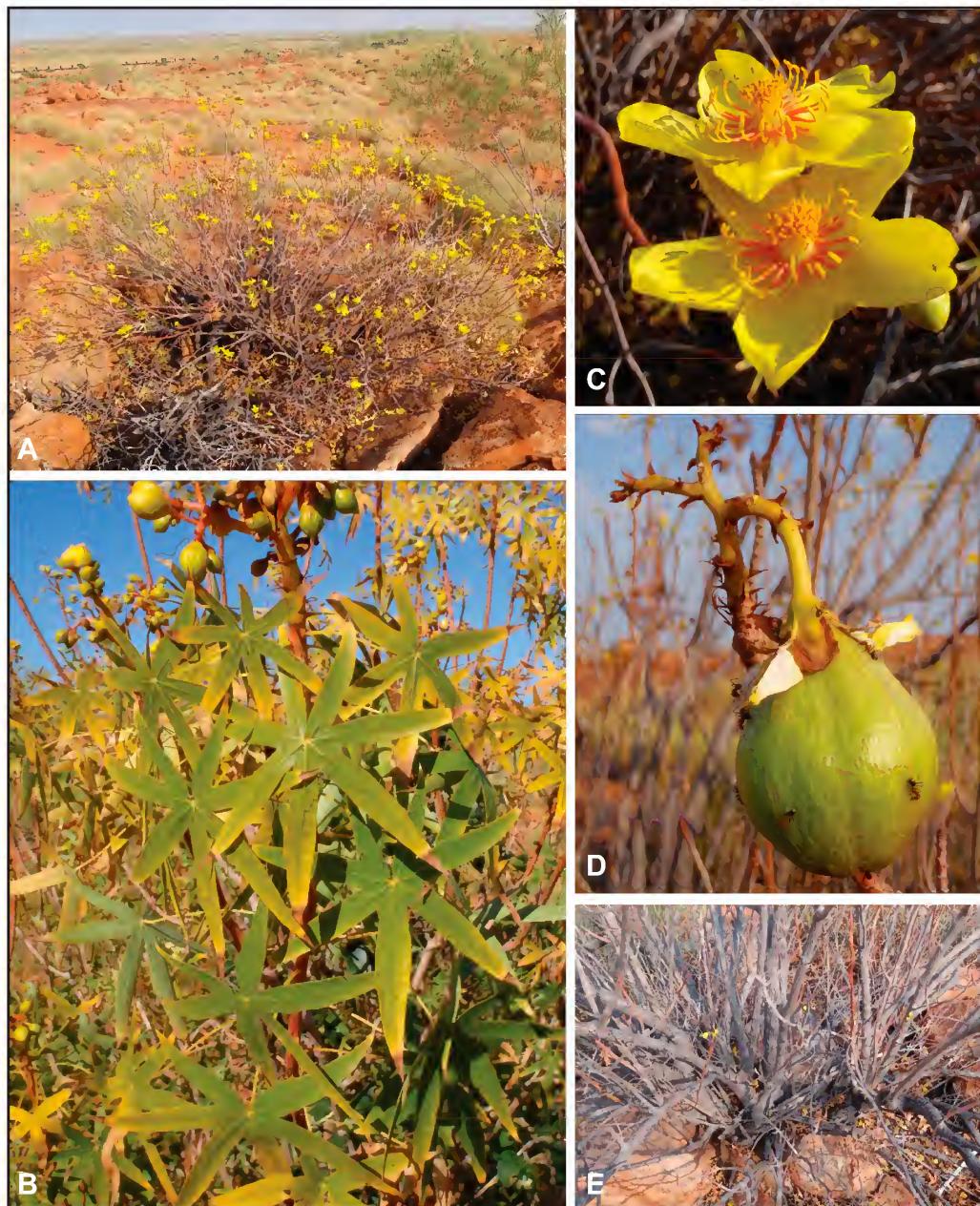


Figure 1. *Cochlospermum macnamarae*. A – habit and habitat; B – mature leaves; C – flowers; D – fruit; E – base of plants showing numerous stems from rootstock. All photos D. Brassington, from the type locality.

*Other specimens examined.* WESTERN AUSTRALIA: [localities withheld for conservation reasons] 30 Sep. 2011, D. Brassington, E. Ager & J. Macknay LCH 31707 (PERTH); 30 Sep. 2011, D. Brassington, E. Ager & J. Macknay LCH 31708 (PERTH); 30 Sep. 2011, D. Brassington, E. Ager & J. Macknay LCH 31755 (PERTH).

*Distribution and habitat.* Currently known only from a small area in the central part of the Pilbara bioregion about 160 km south of Port Hedland (Figure 2), where it occurs on the upper slopes of a low hill in shallow, stony soil closely underlain by granitic bedrock (Figure 3). Plants grow as isolated shrubs over very open *Triodia* grassland.

*Phenology.* Other Australian species of *Cochlospermum*, found in areas with more regular monsoonal wet-dry seasons, are regularly dry season deciduous, mostly losing their leaves completely after the onset of the dry. Flowering typically commences in the Kimberley and Northern Territory as the leaves fall in the early to mid dry season (April–June), with fruiting beginning around June and continuing until new leaf growth commences with storm rains towards the end of the dry season and early wet (I. Cowie, R. Barrett pers. comm.). On low regenerating plants, leaves may emerge following fire in the early dry season.

*Cochlospermum macnamarae*, by contrast, grows in a semi-arid environment with more irregular rainfall. At the time of its collection in late September, plants in the population were at a range of phenological stages. Some had shed most of their leaves, some had a more or less full canopy of mature green leaves while others were at an intermediate stage with some leaves green and others yellowing prior to abscission. Most had at least some flowers present, and fruit was also present on some plants. The exact timing of leaf drop, flowering and new leaf growth in *C. macnamarae* is likely to be determined by local rainfall in the current and preceding season, and may be seasonably variable. Variation between plants within a population is likely to be associated with micro-site differences in degree of exposure and moisture retention.

*Etymology.* The species epithet honours Keiran McNamara, Director General since 2001 of the Department of Conservation and Land Management (CALM) and later the Department of Environment and Conservation (DEC). As Director General, Keiran strongly supported science, including taxonomic research conducted at the Western Australian Herbarium. In particular, his specific support for targeted taxonomic research on potential species of conservation concern resulted in the publication of 154 new plant taxa in Western Australia, 119 of which are conservation-listed. This is a remarkable legacy.

Under the *International Code of Nomenclature for algae, fungi, and plants* (McNeill *et al.* 2012), Mc surnames are spelled in full as Mac when Latinised, and surnames ending with -a are terminated -ae.

*Conservation status.* *Cochlospermum macnamarae* is currently known from a single population of about 180 plants situated mostly on land designated as a rail corridor. This species has been listed, under its phrase name *C. sp.* Pilbara (D. Brassington, E. Ager & J. Macknay LHC 31756), as Priority One under the Department of Environment and Conservation's Conservation Codes for Western Australian Flora (Smith 2012).

*Affinities.* *Cochlospermum macnamarae* is most similar in leaf morphology to *C. gillivraei*, from which it differs in its narrower leaf lobes and smaller flowers. It can be readily distinguished from *C. fraseri*, the only other species known to occur in Western Australia, by its leaves (which are much more deeply lobed), red outer staminal filaments, and low, multi-stemmed, shrubby habit (which contrasts with the single-stemmed, tree-like habit of *C. fraseri*).

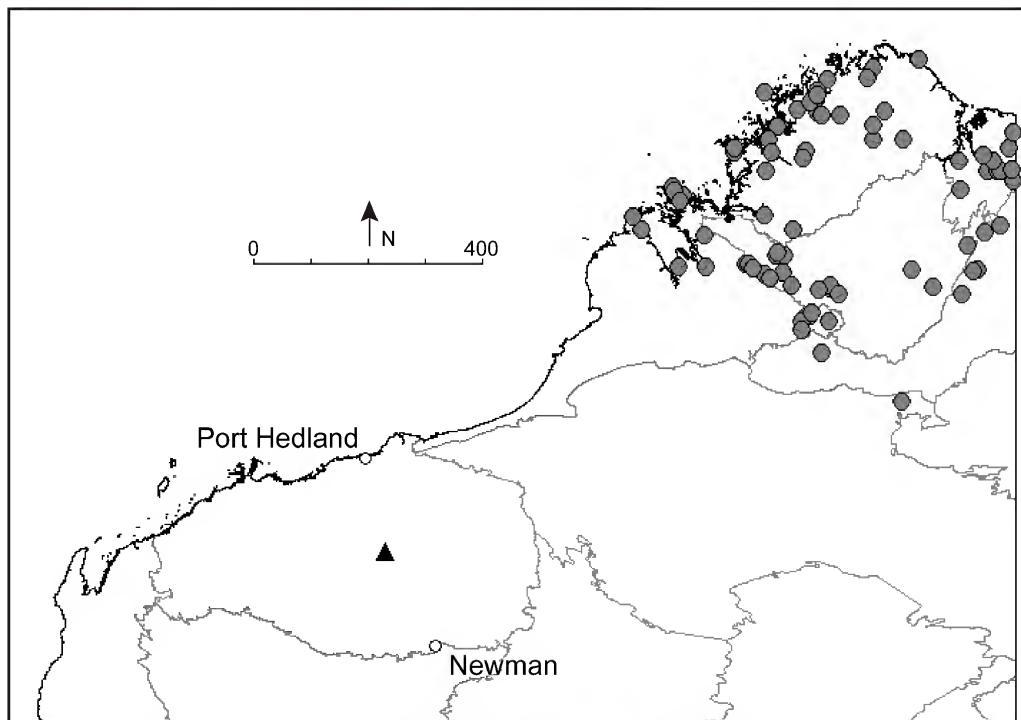


Figure 2. Distribution of *Cochlospermum macnamarae* (▲) and *C. fraseri* (●) in Western Australia.



Figure 3. *Cochlospermum macnamarae* growing in shallow, stony soil closely underlain by granitic bedrock.

### Key to the Australian species of *Cochlospermum*

1. Leaves palmatisect or occasionally the lobes fused for 1–2 mm..... *C. gregorii*
- 1: Leaves palmatifid, divided for up to seven eighths of their length
  2. Leaves usually divided for less than half their length, occasionally up to two thirds, or sometimes ± unlobed; lobes obtuse, but occasionally abruptly mucronulate; staminal filaments all yellow..... *C. fraseri*
  - 2: Leaves always divided for more than half their length, usually between two thirds and seven eighths; lobes acute to acuminate; at least the outer filaments red
    3. Leaf lobes broad (widest lobe (14–)17–40 mm wide at the widest point), narrowly ovate, tapering markedly towards the base, the length: width ratio 2–3.4: 1; petals 29–40 mm long, 12–25 mm wide..... *C. gillivraei*
    - 3: Leaf lobes narrow (widest lobe 7–10 mm wide at the widest point), ± linear, very narrowly ovate or very narrowly elliptic, usually not tapering towards the base, the length: width ratio 5.2–8: 1; petals 22–27 mm long, 13–15 mm wide ..... *C. macnamarae*

### Acknowledgements

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**SHORT COMMUNICATION****'There are greater things in life than cricket': *Tetratheca aphylla* (Elaeocarpaceae), James Drummond and the exploration of the Helena and Aurora Range**

*Tetratheca aphylla* F.Muell. was described by Mueller in 1882 based on a single James Drummond collection. The type sheet has a blue Mueller label with the taxon name and 'J. Dr.', 'W.A.' in Mueller's hand, and in the protologue Mueller gives the origin of the collection as 'West Australia; from the late Mr. James Drummond's collections, in which no indication of the precise locality of this plant is given' (Mueller 1882). No further collections of this species were made for over 100 years, until it was collected in 1979 from 80 km north-east of Bullfinch in the Helena and Aurora Range (K.R. Newbey 5916, PERTH). Collections were also made from the Newdegate area in 1982 (*A. Strid* 21089, PERTH), some 300 km south of the Helena and Aurora Range. All subsequent collections of this species have been made from populations in these two highly disjunct areas. In the Helena and Aurora Range the species is largely confined to massive Banded Iron Formation extending eastward from Bungabbin Hill (Figure 1).

Recent taxonomic studies found subtle but consistent morphological differences between the two disjunct populations, warranting the recognition of two subspecies (Butcher 2007: 145); these morphological differences were supported by molecular data (Butcher *et al.* 2007). As Drummond's type of *T. aphylla* is in poor condition and lacks diagnostic fruits, it was necessary to select an epitype prior to describing a new subspecies in order to unambiguously assign the autonym to either the Helena and Aurora Range or Newdegate populations. Butcher (2007) designated a recent collection from the Helena and Aurora Range (*B.J. Lepisci* 1988) as the epitype because plants from this area most closely approximate Drummond's collection in lacking glandular hair remnants on the stems (which are typical of the Newdegate populations) and in having flowers with more similarly sized petals and stamens to the loose fragments of the type. The new subspecies, *T. aphylla* subsp. *megacarpa* R.Butcher, was then described to encompass collections from near Newdegate with broader fruits. Unfortunately, the epitype designation was invalidly published under Article 7.10 of the *International Code of Nomenclature for algae, fungi and plants* (McNeill *et al.* 2012); this is rectified herein.

A puzzling question is how Drummond obtained material of *T. aphylla*, given that he did not visit either the Helena and Aurora Range or Newdegate areas (Erickson 1969). The recent publication of the diaries of two expeditions that visited the Helena and Aurora Range in 1861 and 1864 looking for new grazing lands (Brooker 2006, 2012) provides a likely resolution to this problem.

The 1861 expedition consisted of Charles and Andrew Dempster, James Drummond's grandson Barnard Clarkson and his friend Charles Harper, and a Noongar man named Correll (Brooker 2006). The expedition diary entry for 23<sup>rd</sup> July 1861, as the expedition approached the Helena and Aurora Range, states 'here we collected several botanical specimens, which were carefully preserved, in order to forward to Mr Drummond'. The expedition spent 24<sup>th</sup> July 1861 exploring Bungabbin Hill

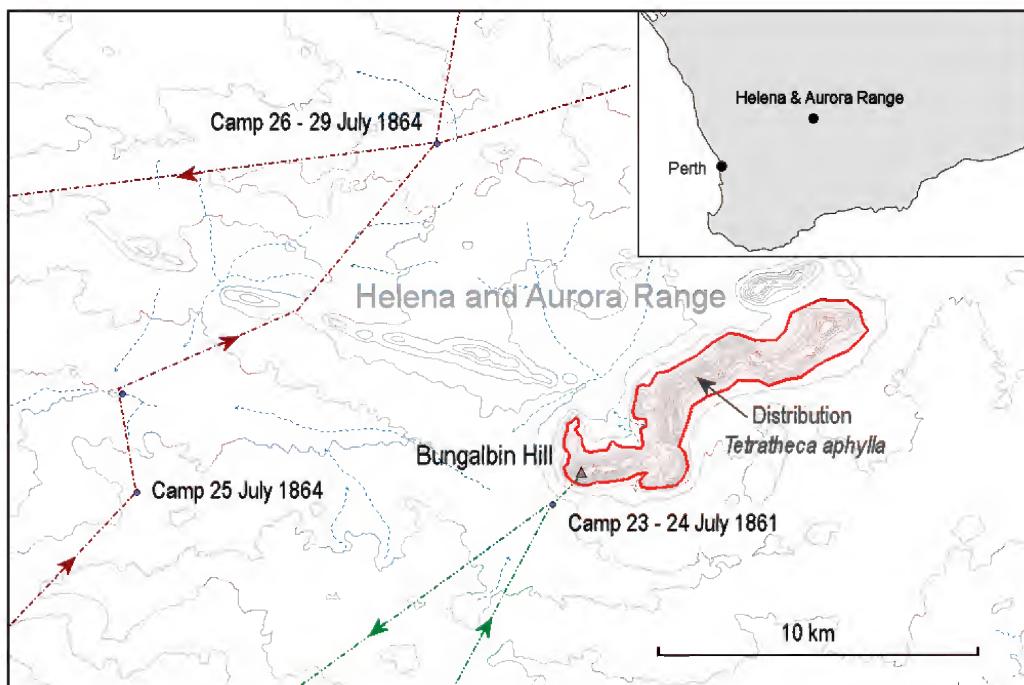


Figure 1. Map of the Helena and Aurora Range region showing the known geographical extent of *Tetratheca aphylla* in the area and the tracks and campsites of the 1861 and 1864 expeditions (based on Brooker 2006, 2012).

(which they called Mt Kennedy), climbing it from the south side (Figure 1). The diary entry records that they collected rock samples but does not record the collection of any plants. This is the furthest inland that the expedition reached, heading south-west the following day back toward Lake Deborah East. The collections from this expedition were presumably given to James Drummond senior on the return of the expedition in August 1861.

The 1864 expedition consisted of Clarkson, Harper, Harper's cousin Lionel Lukin and a Noongar man named Gyngnitch (Brooker 2012). On this expedition they crossed the Helena and Aurora Range to the west of Bungabbin Hill and camped at a rockhole c. 12 km north-west of Bungabbin Hill (Figure 1). They used this rockhole as a base camp for excursions back to the range (looking for a lost knife, 27<sup>th</sup> July), and further afield to Mt Manning (28<sup>th</sup> July) and the Hunt Range (29<sup>th</sup> July). On 30<sup>th</sup> July they moved west to a rockhole below the Jackson Range and spent the 31<sup>st</sup> exploring the Jackson Range, where Harper collected the type of *T. harperi* F.Muell. (Brooker 2012). As Drummond senior died on 26<sup>th</sup> March 1863, material collected on this expedition would not have been forwarded to him. Mueller was likely to have received this material directly, as he used three collections as types for taxa he described in 1865 (Mueller 1865).

Brooker (2006, 2012) documented 18 extant Harper specimens, 17 at the National Herbarium of Victoria (MEL) and one at the Royal Botanic Gardens Kew (K), and published images of 16. All of these specimens have Harper's collection notes attached (Table 1), with the exception of No. 3 (*Cheilanthes brownii*) which bears an annotation by Pemberton Walcott stating that it was 'with the rest of Harper's plants'. Brooker (2006) ascribes four of the numbered specimens (Nos. 2, 5, 8 and 10)

**Table 1.** List of extant Harper specimens showing collection numbers, location information and year collected. The location and date information for the 16 specimens seen is given in Mueller's hand except for *Cheilanthes brownii* and *Tetratheca harperi*, and is reproduced here verbatim. Harper's collection notes are attached for all 16 specimens except *Cheilanthes brownii*.

Number	TAXON	LOCATION	YEAR	COMMENTS
No. 1	<i>Hybanthus floribundus</i> subsp. <i>floribundus</i>	Eastern interior of W. Austr. Mount Marshall		
No. 2	<i>Boronia coerulescens</i> subsp. <i>spinescens</i>	E. interior of W. Austr. Lake Deborah		
No. 3	<i>Cheilanthes brownii</i>	E. interior of W. Austr	1864	No collection notes; Pemberton Walcott notes this specimen was with the Harper collections
No. 4	<i>Keraudrenia velutina</i> subsp. <i>velutina</i>	E. interior of W. Austr	1864	
No. 5	<i>Acacia jibberdingensis</i>	Eastern interior of W. Austr.		
No. 6	<i>Cephaelipterum drum- mondii</i>	Eastern interior of W. Austr.	1864	
No. 7	<i>Eucalyptus orbifolia</i>	Interior of S.W. Austr		K specimen
No. 8	<i>Glycine rubiginosa</i>	Eastern interior of W. Austr.	1864	
No. 10	<i>Ptilotus obovatus</i>	Eastern interior of W. Austr.		Specimen not seen
No. 11	<i>Eremophila serrulata</i>	Eastern interior of W. Austral.	1864	Label inconclusive; <i>s.n.</i> in Brooker (2012), No. 11 in MEL database
No. 12	<i>Pimelea angustifolia</i>	Lake Sapphire		Location information in Harper's notes
No. 13	<i>Lawrencella davenportii</i>	Near Sapphire Lake		
<i>s.n.</i>	<i>Lawrencella davenportii</i>	Near Sapphire Lake		Specimen not seen
No. 15	<i>Rhodanthe chlorocephala</i> subsp. <i>splendida</i>	Eastern interior of W. Austr.		
No. 17	<i>Pityrodia terminalis</i>	Near Mount Walter		
No. 18	<i>Rhagodia preissii</i>	Eastern interior of W. Austr.		
No. 19	<i>Mirbelia microphylla</i>	Between Mt Churchman & Mt Marshal	1864	
<i>s.n.</i>	<i>Tetratheca harperi</i>	...high jasper range amongst rocks.		No Mueller label; location information in Harper's notes

to the 1861 expedition; however, given the sequence of numbers, the consistency of the labelling, and the date of 1864 on six of these specimens (including No. 8), we consider that they were all collected on the 1864 expedition (*cf.* Brooker 2006, 2012).

On the basis of the information in the expedition diaries and the known distribution of *T. aphylla* it seems almost certain that Harper collected the type of *T. aphylla* during the first expedition (on the southern flanks or the summit of Bungabbin Hill on 24<sup>th</sup> July 1861) and subsequently gave the specimen to Drummond. If this collection formed part of Drummond's private herbarium (as seems most likely), Mueller would not have received this material from Drummond's son until 1866 when he states in a letter (5<sup>th</sup> February 1866) to Bentham 'Within the last week I have received Drummonds plants from Swan River; the collection is in a very miserable state...' (Holmes *et al.* 2002).

If our interpretation of the origin of Harper's extant specimens is correct, then the type of *T. aphylla* is the only specimen from the 1861 expedition that has been located. We consider it likely that other specimens from this expedition that were incorporated into Drummond's private herbarium may yet be found in MEL.

Brooker's detailed research has established the connection between James Drummond senior and the Helena and Aurora Range through Charles Harper's expeditions, supporting Butcher's (2007) decision to epitypify *T. aphylla* on a collection from this locality rather than from the Newdegate area.

While the young explorers on these two expeditions went on to become stalwarts of the young Swan River Colony, influencing the institutions of Western Australia down to the current day, the members of the 1864 expedition in particular owed their lives to the aboriginal people through whose lands they travelled (Brooker 2006, 2012). Charles Harper's succinct quote 'There are greater things in life than cricket' stands as a fitting epitaph to the busy and productive lives these young men went on to lead (Brooker 2006, 2012).

### **Typification**

#### **Tetratheca aphylla F.Muell.**

*Type*: Western Australia, *s. dat.*, *J. Drummond s.n.* [Bungalbin Hill, Western Australia, 24 July 1861, *C. Harper s.n.*] (*holo*: MEL 1008033!). *Epitype*: Helena and Aurora Range, Western Australia [precise locality withheld for conservation reasons], 25 September 1995, *B.J. Lepisci* 1988 (*epi*, here designated: PERTH 04182898!; *isoepi*: CANB 500941 *n.v.*).

### **Acknowledgements**

The mystery regarding the connection between Drummond and the Helena and Aurora Range would have persisted without the comprehensive compilation of the early explorers' diaries, interpretative mapping and botanical research recently published by Lesley Brooker. Kevin Thiele, Bruce Maslin and Juliet Wege are thanked for their comments on an earlier draft. RB thanks Jürgen Kellermann (AD) for bringing the invalid publication of the epitype in 2007 to her attention.

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**Neil Gibson<sup>1</sup> and Ryonen Butcher**

Science Division, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

<sup>1</sup>Corresponding author, email: Neil.Gibson@dec.wa.gov.au



**SHORT COMMUNICATION****Correction to the type locality of *Grevillea tenuiloba* (Proteaceae)**

*Grevillea tenuiloba* C.A.Gardner was described by Gardner (1933) from a single specimen collected by W.E. Blackall in September 1932 (PERTH 01702742). The type locality is recorded by Gardner as ‘near Dandaragan’; however, the species has never been recollected in the Dandaragan area. It is restricted to the northern Avon Wheatbelt where it is associated with granite outcrops (Western Australian Herbarium 1998–).

An examination of Blackall’s collecting books has revealed that he made 29 *Grevillea* collections in 1932. Blackall provided names for all of these collections, with the exception of the following record, which he referred to as *G. sp. nov.*: ‘Sept. 24, Bet. Mullewa and Morawa, 2809 *Grevillea*, fls. amber, low S. of 2 ft spreading’. The relevant specimen (PERTH 01938177), which is referable to *G. tenuiloba*, only became part of the Western Australian Herbarium collection in 1960 when Blackall’s collection was transferred from the Western Australian Museum.

PERTH 01938177 matches the holotype of *G. tenuiloba* and I consider them to be duplicates of the same gathering despite the labelling discrepancy. Blackall often gave Gardner a part of a collection, usually with a numbered tag attached. In this case, the tag and associated collection information have been mislaid, causing Gardner to make an error with regards to the type locality. The type citation is therefore revised as follows:

***Grevillea tenuiloba* C.A.Gardner, J. Roy. Soc. Western Australia 19: 81 (1933). Type:** Avon district, near Dandaragan [between Mullewa and Morawa], Western Australia, [24] September 1932, *W.E. Blackall* [2809] (*holo*: PERTH 01702742; *iso*: PERTH 01938177).

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With thanks to Kevin Thiele, Mike Hislop, Juliet Wege, and Beng Siew Mahon.

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**Margaret Lewington**

Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983



## Two Western Australian species of *Ozothamnus* transferred to *Pithocarpa* (Asteraceae: Gnaphalieae)

Russell L. Barrett<sup>1,2,3</sup>, Alexander N. Schmidt-Lebuhn<sup>4</sup> and Kevin R. Thiele<sup>3</sup>

<sup>1</sup>Botanic Gardens and Parks Authority, Kings Park and Botanic Garden,  
West Perth, Western Australia 6005

<sup>2</sup>School of Plant Biology, Faculty of Natural and Agricultural Sciences,  
The University of Western Australia, Crawley, Western Australia 6009

<sup>3</sup>Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

<sup>4</sup>CSIRO Plant Industry, Centre for Australian National Biodiversity Research,  
GPO Box 1600, Canberra, ACT 2601

<sup>1</sup>Corresponding author, email: russell.barrett@bgpa.wa.gov.au

### Abstract

Barrett, R.L., Schmidt-Lebuhn, A.N. & Thiele, K.R. Two Western Australian species of *Ozothamnus* transferred to *Pithocarpa* (Asteraceae: Gnaphalieae). *Nuytsia* 23: 103–108 (2013). Two Western Australian species currently referred to the genus *Ozothamnus* R.Br. have in the past been considered poorly aligned with that genus, but their alternative placement has been uncertain. Recent molecular studies have suggested that they are best placed in the Western Australian endemic genus *Pithocarpa* Lindl. The following new combinations are made: *Pithocarpa cordata* (DC.) Schmidt-Leb. & R.L.Barrett and *Pithocarpapramosa*(DC.)Schmidt-Leb. & R.L.Barrett. Four species are now recognised in *Pithocarpa* and all are listed here. A key to the expanded genus is provided. Scanning electron micrographs are provided for a range of features for all taxa.

### Introduction

Species treated here have all been included in a broadly defined *Helichrysum* Mill. in the past (Candolle 1838; Burbidge 1958). With the segregation of all Australian native taxa as distinct genera from *Helichrysum* (Wilson 1992, 2008a, 2008b, in prep.; Anderberg *et al.* 2006), the placement of a number of Western Australian taxa has been considered problematic. Anderberg (1991) revised the classification of the tribe Gnaphalieae and concluded that *Helichrysum cordatum* DC. was best accommodated in a broadly defined *Ozothamnus* R.Br. until more data could be obtained on its relationships. Wilson *et al.* (1992), also hesitant as to the correct placement of this species, nevertheless transferred the closely related *Helichrysum ramosum* DC. to *Ozothamnus* for consistency. In revising the Australian species of *Helichrysum*, Burbidge (1958) included these two species in the small section *Hebelaena* (DC.) N.T.Burb.; they are the only Western Australian representatives of the section.

The genus *Pithocarpa* Lindl. was established by Lindley (1839), revised by Lewis and Summerhayes (1951) and revised again by Lepschi (1999). It currently comprises three taxa (*P. corymbulosa* Lindl. and two varieties of *P. pulchella* Lindl.) and is endemic in the south-west of Western Australia. Various relationships for *Pithocarpa* have been proposed by earlier authors (see Lepschi 1999).

A recent molecular study by Schmidt-Lebuhn and Constable (2012) found strong support for a clade comprising *Pithocarpa*, *O. cordatus* (DC.) Anderb. and *O. ramosus* (DC.) Paul G. Wilson based on ETS and ITS nrDNA sequence data. This clade was placed well outside of the large and strongly supported clade comprising the core of *Ozothamnus*, *Cassinia* R.Br. and related genera. While generic limits in the larger clade remain uncertain, the basal position of the small *Pithocarpa* clade and its endemism in Western Australia means that it is likely to remain distinct at generic rank no matter what circumscriptions are adopted in the larger clade.

Morphologically, *O. cordatus* and *O. ramosus* share with the two *Pithocarpa* species a perennial, openly tangled habit, short-lived branches, a dense, cobwebby indumentum and radiating, white, petaloid bracts. The eastern Australian members of ‘sect. *Hebelaena* (DC.) N.T.Burb.’<sup>1</sup> have herbaceous, non-radiating bracts and a different habit (though *O. whitei* (N.T.Burb.) Anderb. is similar in habit). Comparative illustrations are provided in Figures 1 and 2.

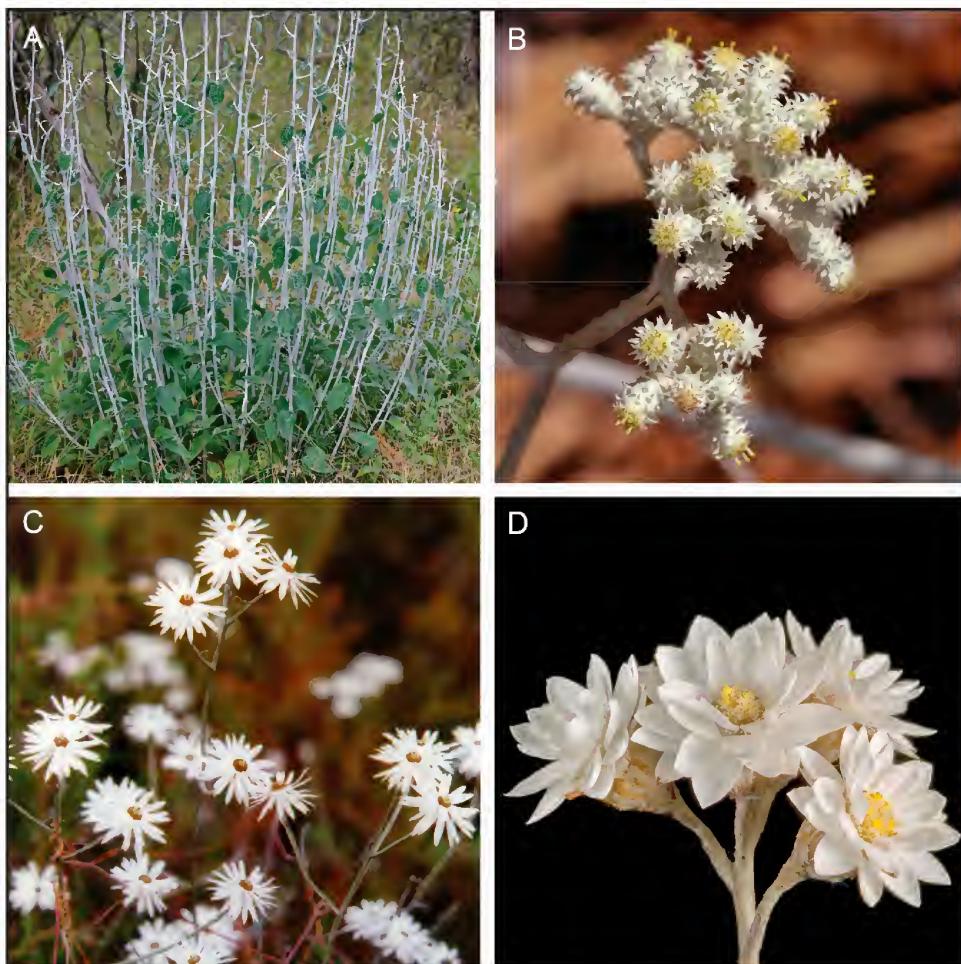


Figure 1. Comparative photographs of *Pithocarpa* species. A, B – *P. cordata* (Kings Park, unvouchered, photographs by R. Barrett). C, D – *P. pulchella* var. *pulchella* (C – Ellis Brook Valley Reserve, voucher H. Bowler 325 photograph by H. Bowler; D – Badgingarra, voucher K.R. Thiele 3200, photograph by K. Thiele).

<sup>1</sup>While the species included under *Helichrysum* sect. *Hebelaena* by Burbidge (1958) have continued to be recognised as a distinct group under *Ozothamnus*, the section name has never been officially combined under *Ozothamnus*.

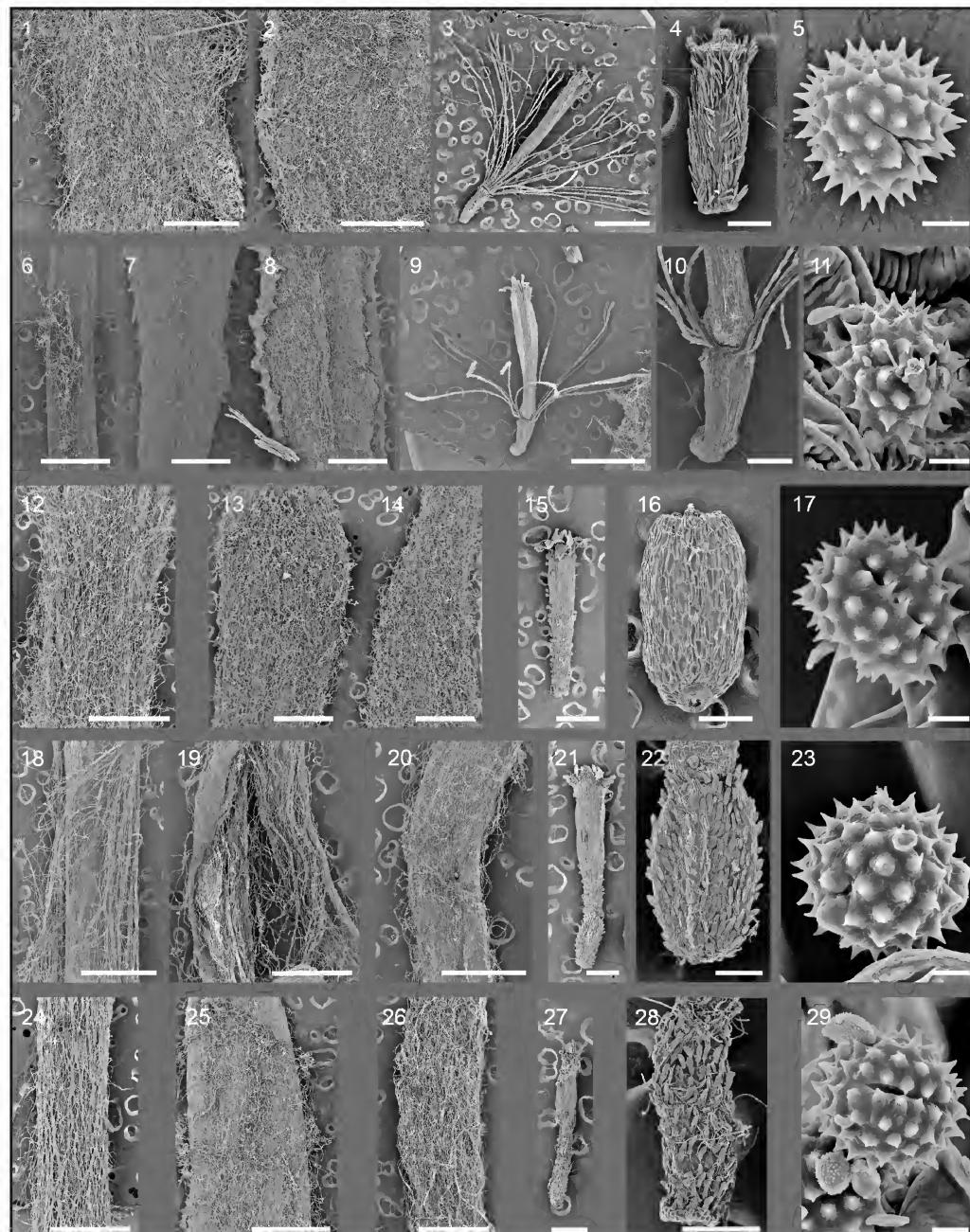


Figure 2. Scanning electron micrographs of *Pithocarpa* taxa, from left to right in each row: stem indumentum; leaf indumentum (adaxial and abaxial; adaxial only for *P. cordata*); flower; achene; pollen. 1–5 – *P. cordata* (C.A. Hortin 8/27, PERTH 04191684). 6–11 – *P. ramosa* (E.J. Croxford 4962, PERTH 04434668). 12–17 – *P. corymbulosa* (F. Hort 1016, PERTH 05604745). 18–23 – *P. pulchella* var. *melanostigma* (B.J. Lepisci & T.R. Lally BJL 2591, PERTH 04489667). 24–29 – *P. pulchella* var. *pulchella* (B.J. Lepisci & T.R. Lally BJL 2889, PERTH 04687841). Scale bars: 1–3, 6–9, 12–15, 18–20, 24–26 = 1 mm. 15, 21, 27 = 500 µm. 4, 10, 16, 22, 28 = 200 µm. 5, 11, 17, 23, 29 = 5 µm. Images by R. Barrett.

*Ozothamnus cordatus* and *O. ramosus* were included in *Ozothamnus* based on the presence of a pappus of barbed bristles, which in these two species are fused at the base to form a ring and is shed whole (Burbidge 1958). This character is not unique to *Ozothamnus*, being found in a number of related genera including *Cassinia* (Orchard 2004). The two species of *Pithocarpa s. str.* lack a pappus (Lepschi 1999). While the presence or absence of the pappus has traditionally been considered to be of great taxonomic importance in the Asteraceae, it is now widely recognised as highly homoplasious and of limited taxonomic utility (Anderberg 1991; Schmidt-Lebuhn & Constable 2012). Loss of the pappus has occurred multiple times in the *Ozothamnus-Cassinia* clade (Schmidt-Lebuhn & Constable 2012).

The new combinations under *Pithocarpa* are provided here in order to make the names available for a revised edition of *Perth plants* (Barrett & Pin Tay 2005). Descriptions and illustrations of these taxa can variously be found in Burbidge (1958), Grieve and Blackall (1982), Lander (1987), Lepschi (1999) and Wheeler (2002).

## Methods

Illustrations are based on photographs of live plants and from herbarium material. Scanning electron microscope images were taken on a Jeol JCM 5000 NeoScope bench-top SEM at Kings Park and Botanic Garden.

### Key to taxa of *Pithocarpa*, based on Burbidge (1958) and Lepschi (1999)

1. Pappus present, the bristles fused into a basal ring
  2. Plants densely tomentose except on the upper surfaces of the leaves which are sparsely tomentose, leaves ovate to cordate. Laminae of bracts acute ..... ***P. cordata***
  - 2: Plants glabrescent, leaves linear to oblanceolate, scabrid above, tomentose or glabrescent below. Laminae of bracts obtuse ..... ***P. ramosa***
- 1: Pappus absent
  3. Involucral bracts without dark pigment; capitula in more or less compact, well-defined corymbs of 2–11 capitula, rarely solitary on lateral branches within the flowering region; ovary and cypsela glabrous.  
(Darling Range E of Perth) ..... ***P. corymbulosa***
  - 3: At least some involucral bracts marked with dark reddish maroon on the abaxial surface; capitula in open, loose corymbs of 2–6 capitula, as well as solitary, on lateral branches within the flowering region; ovary and cypsela with antrorse, clavate duplex hairs.  
(Widespread in SW WA)
    4. Style branches black or very dark brownish black, both in life and when dried ..... ***P. pulchella* var. *melanostigma***
    - 4: Style branches yellowish brown to brown (in life), drying brown ..... ***P. pulchella* var. *pulchella***

## Taxonomy

***Pithocarpa*** Lindl., *Sketch Veg. Swan R.* 23 (1839). *Lectotype*: *Pithocarpa pulchella* Lindl., designated by P. Lewis & V.S. Summerhayes, *Kew Bull.* 5(3): 436 (1951).

*Helichrysum* subser. *Hebelaena* DC., *Prodr.* 6: 180 (1838); *Helichrysum* sect. *Hebelaena* (DC.) N.T.Burb., *Austral. J. Bot.* 6(3): 235 (1958). *Lectotype*: *H. cordatum* DC., designated by N.T. Burbidge, *loc. cit.* (1958).

***Pithocarpa cordata* (DC.) Schmidt-Leb. & R.L.Barrett, *comb. nov.***

*Helichrysum cordatum* DC., *Prodr.* 6: 180 (1838); *Gnaphalium cordatum* (DC.) Sch.Bip., *Bot. Zeitung (Berlin)* 3: 170 (1845); *Ozothamnus cordatus* (DC.) Anderb., *Opera Bot.* 104: 89 (1991). *Type*: Western Australia: Barren shores of King George Sound, 1818, *A. Cunningham* (*lecto*: G-DC n.v., designated by N.T. Burbidge, *Austral. J. Bot.* 6(3): 241 (1958); possible *iso*: K n.v.).

***Pithocarpa corymbulosa* Lindl.**, *Sketch Veg. Swan R.* 23 (1839); *Humea corymbulosa* (Lindl.) F.Muell., *Vict. Naturalist* 9: 144 (1893); *Calomeria corymbulosa* (Lindl.) Heine, *Adansonia* ser. 2, 7: 138 (1967). *Type*: Western Australia: Swan River [Colony, 1830s, *A.*] *Toward* s.n. (*holo*: CGE, photo seen at PERTH).

***Pithocarpa pulchella* Lindl.**, *Sketch Veg. Swan R.* 23 (1839). *Type*: Western Australia: Swan River [Colony, 1835–1838], *J. Drummond* s.n. (*holo*: CGE, photo seen at PERTH; possible *iso*: US Sheet No. 230363, barcode 00623569, image seen).

*Pithocarpa major* Steetz in Lehm., *Pl. Preiss.* 1(3): 446 (1845). *Type*: Western Australia: ‘In solo glareoso - sublimoso planitiei sylvae supra oppidulum Guildford’ [In muddy gravel in woodland on the plain beyond the village of Guildford], 9 August 1839, *L. Preiss* s.n. (*type*: LD 1210036, image seen; MEL 238727 n.v.).

*Note*. The two sheets representing the type of *P. major* were probably both seen by Steetz, so both have equal type status. We have no reason to choose a lectotype or to assume they are from different gatherings, so we simply list both as type specimens with no additional status.

*Pithocarpa achilleoides* P.Lewis & Summerh., *Kew Bull.* 5(3): 437–438 (1951). *Type*: Western Australia: Wooroloo, November 1907, *M. Koch* 1895 (*holo*: K n.v.; *iso*: NSW 397293 n.v.).

***Pithocarpa pulchella* var. *melanostigma* (P.Lewis & Summerh.) Lepschi**, *Nuytsia* 13: 71 (1999); *Pithocarpa melanostigma* P.Lewis & Summerh., *Kew Bull.* 5(3): 438–439 (1951). *Type*: Western Australia: ‘District southwest Plantagenet [District of South West Plantagenet], in scrub on damp hills not far from the sea’, January 1901, *E.G. Pritzel* 243 (*holo*: K n.v.; *iso*: AD 97632397 n.v., NSW 397306 n.v.; US Sheet No. 406171, barcode 00623573, image seen).

***Pithocarpa pulchella* Lindl. var. *pulchella***

***Pithocarpa ramosa* (DC.) Schmidt-Leb. & R.L.Barrett, *comb. nov.***

*Helichrysum ramosum* DC., *Prodr.* 6: 181 (1838); *Gnaphalium ramosum* (DC.) Sch.Bip., *Bot. Zeitung (Berlin)* 3: 170 (1845), nom. illeg., non Lam., *Fl. Franç.* 2: 65 (1779); *Ozothamnus ramosus* (DC.) Paul G.Wilson, *Muelleria* 7: 521 (1992). *Type*: Western Australia: shores of King George Sound, *s. dat.*, *A. Cunningham* s.n. (*holo*: G-DC, n.v.).

*Helichrysum gracile* DC., *Prodr.* 6: 181 (1838); *Gnaphalium georgii* Sch.Bip., *Bot. Zeitung (Berlin)* 3: 170 (1845). *Type:* Western Australia: dry barren land, King George Sound, *s. dat.*, *A. Cunningham s.n.* (*holo*: G-DC *n.v.*; *iso*: K *n.v.*).

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**Pleurocarpaea gracilis (Asteraceae: Vernonieae), a new species from the Pilbara region of Western Australia****Nicholas S. Lander<sup>1</sup> & P. Johan H. Hurter<sup>2</sup>**<sup>1</sup>Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983<sup>2</sup>GHD, 239 Adelaide Terrace, Perth, Western Australia 6004<sup>1</sup>Corresponding author, email: Nicholas.Lander@dec.wa.gov.au**Abstract**

Lander, N.S. & Hurter, P.J.H. *Pleurocarpaea gracilis* (Asteraceae: Vernonieae), a new species from the Pilbara region of Western Australia. *Nuytsia* 23: 109–115 (2013). A new species of Asteraceae, *Pleurocarpaea gracilis* Lander & P.J.H.Hurter, is described from the Pilbara region of Western Australia. A key to all three species now included in *Pleurocarpaea* Benth. is provided.

**Introduction**

Surveys of the extensive Banded Iron Formation ranges of the Pilbara region of Western Australia in recent years have led to the discovery of a significant number of plant taxa new to science. Amongst them is the new species described here, discovered in 1998 by Dr Stephen van Leeuwen at two isolated locations in the Hamersley Range of Western Australia, with subsequent specimens collected by Emil Thoma in 2011, Steven Kern in 2012 and Hayley Hughes in 2012.

A number of characteristics of the new species described here place it in the tribe Vernonieae Cass., notably its alternate leaves with undivided blades, corymbiform capitulescence, separate homogamous heads with perfect florets, style branches with stigmatic papillae covering the whole inner surface, and pappus of capillary bristles. The taxonomy of the Vernonieae is in a state of considerable flux. A comprehensive key to sub-tribes and genera of Vernonieae was provided by Robinson (2007). However, the overview of the tribe by Keeley and Robinson (2009) presents a substantial reorganisation of the former classification and the recognition of a number of new sub-tribes, amongst them the Linziinae S.C.Keeley & H.Rob.

Characters indicating that the new species belongs in the Linziinae include its suffruticose habit, stem indumentum with simple and L- or T-shaped hairs, alternate leaves with pinnate venation, persistent involucral bracts, epaleate receptacle, bluish corollas, glabrous anther appendages with somewhat thickened cell walls, and style appendages with acicular sweeping hairs. Although available specimens lack fully mature achenes, it otherwise fits broadly within the only genus of that sub-tribe native to Australia, namely *Pleurocarpaea* Benth. as re-described by Dunlop (1991). Given that the sites at which it has been found are difficult to access and little visited, the new species would seem best placed in *Pleurocarpaea* pending the availability of specimens with fully mature achenes and further research on Australian Vernonieae.

*Pleurocarpaea* is the only Australian endemic genus in the Vernonieae (Keeley & Robinson 2009). It was first described by Bentham (1867) from specimens collected by Robert Brown in 1803 with a single species, *P. denticulata* Benth., now known to have a range extending from Cape York Peninsula in Queensland to the North Kimberley in Western Australia. A second species first collected in 1972 and described by Dunlop (1991) as *P. fasciculata* Dunlop, is confined to Arnhem Land. Keeley and Robinson (2009: 457) remark that *Pleurocarpaea* has been isolated with no direct connection to another landmass within the time frame for Astereaceae evolution (maximum age c. 60 million years), and that it is 8,000 km from Australia to Africa where its nearest relatives are to be found.

## Methods

The descriptive terminology used in this paper follows Radford (1986). For more specific terms applied to the Asteraceae we have followed Roque *et al.* (2009). The map was prepared using the program DIVA-GIS (Hijmans *et al.* 2011). Distribution is summarised in terms of the *Interim Biogeographic Regionalisation for Australia (IBRA 6.1)* (Department of Sustainability, Environment, Water, Population and Communities 2000, revised 2004).

### Key to species of *Pleurocarpaea* (modified from Dunlop 1991)

1. Pappus of ± 30 capillary bristles to 3.8–4.9 mm long..... ***P. gracilis***
- 1: Pappus absent or of 1–10 smooth or glandular-hairy bristles to 1 mm long, or bristles minute in a continuous ring
  2. Stems annual; leaves 5–50 mm wide; capitula 8–18 mm long (WA; NT; Qld)..... ***P. denticulata***
  - 2: Stems perennial; leaves 2–7 mm wide; capitula 6.4–8.0 mm long (Arnhem Land, NT)..... ***P. fasciculata***

## Taxonomy

### ***Pleurocarpaea gracilis* Lander & P.J.H.Hurter, sp. nov.**

*Type:* Hamersley Range, Western Australia [precise locality withheld for conservation reasons], 14 October 1998, S. van Leeuwen 4345 (*holo*: PERTH 06230512!, *iso*: BRI!, DNA!, K!).

*Genus* sp. Hamersley Range hilltops (S. van Leeuwen 4345), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 16 January 2012].

Perennial suffruticose herb to 40 cm high. *Stems* divaricate, smooth, angular, without wings, weakly tomentose with submoniliform, rather L-shaped hairs, T-shaped hairs, and minutely stipitate glands. *Leaves* widely spaced, alternate, sessile, spreading; lamina elliptic, 1.8–9.1 mm long × 1.3–5.3 mm wide, strongly pinnately veined, punctate with minutely stipitate glands (appearing sessile) and scattered short moniliform hairs, denser abaxially; base cuneate; margins crenulate and undulate (crispated); apex obtuse, minutely apiculate. *Capitulescences* corymbose-paniculiform. *Heads* pedunculate, 0.7 cm wide, homogamous. *Involucral bracts* imbricate in 3–4 series, gradate, herbaceous; lamina narrowly obovate to narrowly elliptic, 1.6–3.1 mm long × 0.4–0.8 mm wide, densely pubescent dorsally with submoniliform, rather L-shaped hairs and apparently sessile glands; margins entire, ciliate; apex acute, mucronate. *Receptacle* shallowly convex, 2.4 mm diam., epaleate but with minute membranous chaffy projections. *Florets* 15 per head, tubular, overtopping the involucre at anthesis, perfect, narrowly infundibular, 5-lobed, blue to purple, 5.0–6.0 mm long; lobes narrowly acute, 2.3–2.5 mm long, erect;

dorsal surfaces densely covered with apparently sessile glands. *Anthers* coherent, 2.5–2.7 mm long; bases calcarate, ecaudate, sagittate, the auricles narrowly acute; staminal filaments inserted ± midway down the corolla tube; filament collar (connective) shorter than the anther bases; apical appendages flat, acuminate, eglandular. *Styles* bifid, 6 mm long; base slightly swollen and sclerified; upper shaft and outer surfaces of branches densely hairy with uniseriate multicellular sweeping hairs; branches linear, 1.8 mm long, narrowly acute apically; appendages lacking; stigmatic papillae covering whole inner surface of branches. *Achenes* triquetrous, 0.8–1.5 mm long × 0.6–1.3 mm diam. apically and 0.2–0.3 mm basally; ± densely sericeous throughout with long uniseriate multicellular hairs, and with scattered sessile multicellular glands becoming denser basally; carpodium a conspicuous ring of swollen cells. *Pappus* of c. 30± equal capillary bristles, 3.8–4.9 mm long, uniseriate. (Figures 1, 2A, B)

*Specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 3 June 2012, H. Hughes Opp3-2 (PERTH); 9 May 2012, S. Kern WH12125-05 (PERTH); 9 May 2012, S. Kern Opp07 (PERTH); 14 May 2012, S. Kern Opp22 (PERTH); 4 June 2012, S. Kern Opp28 (PERTH); 16 May 2012, S. Kern Opp31 (PERTH); 5 June 2012, S. Kern Opp59 (PERTH); 7 July 2011, E. Thoma 1596 (PERTH, DNA); 15 Oct. 1998, S. van Leeuwen 4387 (PERTH).

*Flowering period.* May–October.

*Distribution.* Locally common at ten sites 2–51 km apart in the Hamersley sub-region of the Pilbara bioregion in the Eremaean Botanical Province of Western Australia (Figure 3).

*Habitat.* Summits, slopes and sheltered gullies of rounded hills in skeletal, red, gritty soil over massive banded ironstone of the Brockman Iron Formation; amongst woodland with *Eucalyptus*, *Acacia*, *Hakea*, *Triodia*, *Dampiera* and *Waltheria* species.

*Conservation status.* Priority Three under the Department of Environment and Conservation's (DEC) Conservation Codes for Western Australia Flora. Originally listed in 2003 as Priority One under *Genus* sp. Hamersley Range hilltops (S. van Leeuwen 4345) when it was only known from two summits of the Hamersley Range (Smith 2012). Since then this taxon has been found at only ten sites 2–51 km apart and is still in need of further survey.

*Etymology.* The specific epithet, *gracilis*, refers to the delicate habit of this species.

*Distinguishing features.* *Pleurocarpaea gracilis* shares with *P. fasciculata* its annual habit. The receptacle of *P. gracilis* is epaleate but with minute membranous chaffy projections, whereas those of both *P. denticulata* and *P. fasciculata* are paleate. *Pleurocarpaea gracilis* differs from both *P. denticulata* and *P. fasciculata* in possessing a pappus of ± 30 long rather than 1–10 short bristles which are sometimes lacking altogether. The pappus bristles of *P. gracilis* are capillary rather than smooth or glandular hairy (*P. denticulata*) or hairy (*P. fasciculata*).

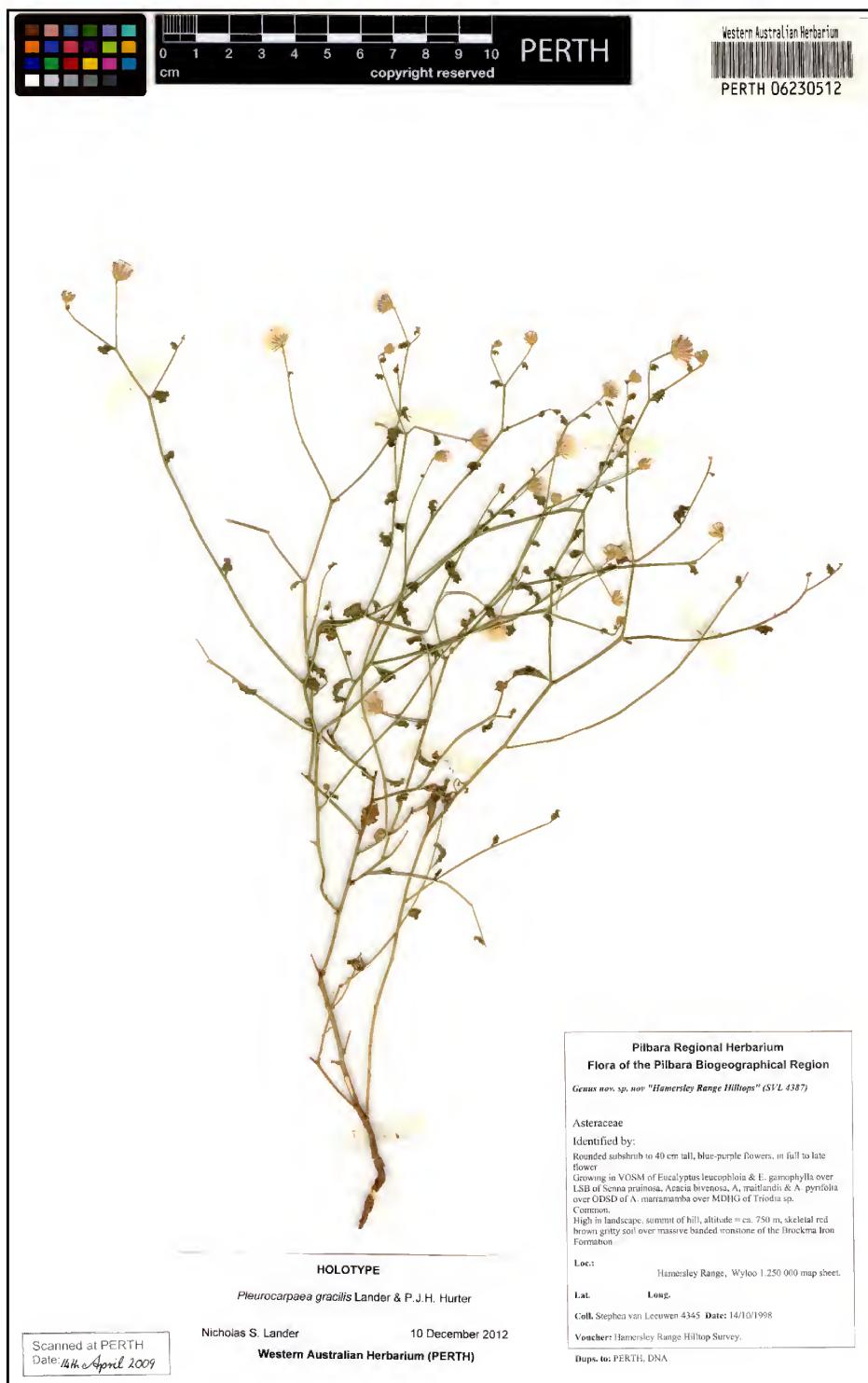
Figure 1. Holotype of *Pleurocarpaea gracilis*.



Figure 2. *Pleurocarpaea gracilis*. A – habit and habitat; B – detail. Photographs by Steve Kern, unvouchered.

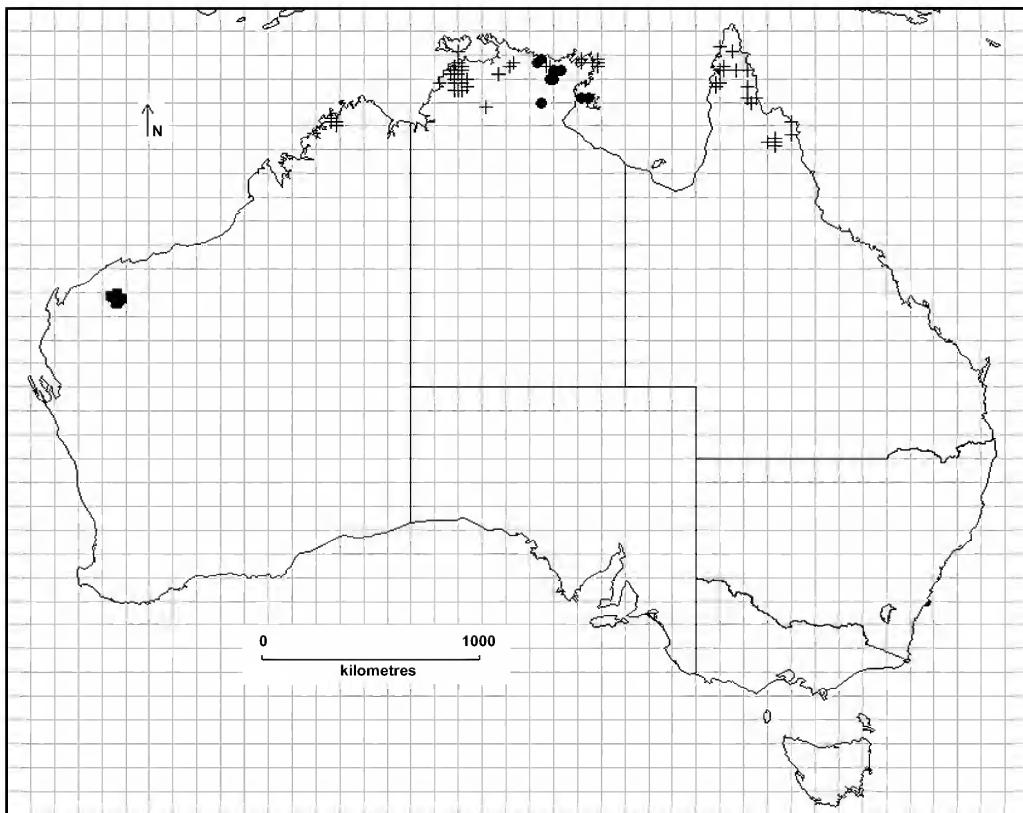


Figure 3. Distribution of *Pleurocarpaea gracilis* (■), *P. fasciculata* (●) and *P. denticulata* (+).

### Acknowledgements

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## Pilbara, a new genus of Asteraceae (tribe Astereae) from Western Australia

**Nicholas S. Lander**

Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983  
Email: Nicholas.Lander@dec.wa.gov.au

### Abstract

Lander, N.S. *Pilbara*, a new genus of Asteraceae (tribe Astereae) from Western Australia. *Nuytsia* 23: 117–123 (2013). A new monotypic composite genus endemic to the Hamersley Range of Western Australia is described and the new species *Pilbara trudgenii* Lander is illustrated and mapped. Its affinities within the tribe Astereae Cass. are discussed. The new species is an obligate lithophyte.

### Introduction

Surveys of the extensive Banded Iron Formation ranges of the Pilbara region of Western Australia in recent years have discovered a significant number of plant species new to science. Amongst them is *Pilbara* Lander, the new genus and species described here, discovered in 1985 by Colma Keating and Malcolm Trudgen, east of Paraburdoo in the Pilbara region of Western Australia.

*Pilbara* appears best placed in the tribe Astereae Cass. which are mostly characterised by their ecaudate, ecalcarate anther bases (though a few genera have caudate anther bases), totally separated stigmatic lines of the style, and short to elongate and deltate-triangular stylar appendages that are glabrous adaxially and with sweeping-hairs abaxially (Nesom & Robinson 2007: 284–285; Brouillet *et al.* 2009: 589).

Within the Astereae, *Pilbara* appears to belong to the subtribe Grangeinae Benth. in the Nesom and Robinson (2007) classification where it seems to be closest to the Australian genus *Erodiocephalum* F.Muell. This is further discussed below.

### Methods

The descriptive terminology used in this paper follows Radford (1986). For more specific terms applied to the Asteraceae I have followed Jeffrey (2007).

The map was prepared using the program DIVA-GIS 7.5 (Hijmans *et al.* 2011). Distribution is summarised in terms of the Interim Biogeographic Regionalisation for Australia (IBRA 6.1) established by Environment Australia (2000, revised 2004).

## Taxonomy

**Pilbara** Lander, *gen. nov.*

Aromatic shrubs. Vestiture of vegetative parts comprising multicellular, biseriate, capitate glandular trichomes. Leaves alternate, clasping. Capitulescences corymbiform. Heads homomorphic, discoid, homogamous, pedunculate. Receptacles strongly convex, paleate; paleae similar to the inner involucral bracts. Disc florets many, tubular, hermaphrodite; anthers ecaudate and ecalcarate basally, with triangular sterile apical appendages; stylar arms with stigmatic lines separate and triangular sterile appendages bearing minute sweeping-hairs. Achenes ellipsoid, sericeous with duplex hairs, 5-ribbed, carpodium inconspicuous. Pappi uniserial, with barbellate bristles *c.* half as long as the florets.

*Type:* *Pilbara trudgenii* Lander

The generic name refers to the region in Western Australia to which this taxon is endemic.

**Pilbara trudgenii** Lander, *sp. nov.*

*Typus:* east of Paraburadoo, Western Australia [precise locality withheld for conservation reasons], 24 October 1985, C.D.M. Keating 411 & M.E. Trudgen (*holo*: PERTH!, *iso*: AD!, DNA!, K!, NSW!).

Aromatic *shrub* to 0.6 m high, becoming straggling with age. *Vegetative parts* hispid; vestiture dense, with patent, multicellular, biseriate, capitate, glandular trichomes. *Stems* ascending; bark exfoliating, fissured and fibrous, mottled cream and grey becoming dark grey. *Leaves* alternate, crowded apically, ascending, clasping; petiole 3–12 mm long; lamina flat, narrowly to broadly ovate, obovate, elliptic or spatulate, 20–50 mm long × 7–32 mm wide, discolored, abaxially pale yellow-brown, adaxially pale to mid-green, both surfaces pustulate; venation distinct, reticulate with prominent mid-vein; vestiture uniform, densely glandular with long capitate trichomes; texture herbaceous; base attenuate; margin double serrate, flat; apex acute, muticous. *Capitulescences* corymbiform. *Heads* pedunculate, discoid, 13–20 mm diam.; peduncle 4–20 mm long × 0.7–1.3 mm diam.; bracts several, grading into those of the involucre. *Involucre* broadly conic; bracts 3–5-seriate, pale to light green, 6.0–10.5 mm long × 0.4–1.5 mm wide, glandular with short and long capitate hairs and multicellular, uniserial, simple eglandular hairs, entire; outer bracts flat, narrowly obovate, pale yellow, uniformly moderately to densely glandular, entire, acute to acuminate apically; inner bracts cymbiform, elliptic to very narrowly obovate, pale green to yellow, weakly to densely glandular abaxially, glabrous adaxially, entire, narrowly acute to acuminate apically. *Receptacle* strongly convex, paleate; paleae similar to the inner involucral bracts. *Disc florets* white, 44–53, infundibular, 8–10 mm long, with multicellular, biseriate, simple eglandular trichomes scattered basally to centrally; lobes 5, 2.0–2.6 mm long, acute; anthers 3.00–3.75 mm long, ecaudate, ecalcarate, acute basally, with triangular sterile apical appendages; filament collar 0.3–0.7 mm long; stylar arms 2.5–3.1 mm long × 0.5 mm wide, with stigmatic lines separate and triangular sterile appendages bearing minute botuliform to cylindric sweeping-hairs. *Achene* ellipsoid, 3.3–4.6 mm long × 0.9–1.5 mm wide, pale brown, uniformly densely sericeous with duplex hairs, 5-ribbed, obtuse basally, truncate apically; carpodium inconspicuous, oblique. *Pappus* uniserial, with 25–29 barbellate bristles *c.* half as long as the florets, often with a single short bristle. *Chromosome number* unknown. (Figures 1, 2)

*Specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 24 Oct. 1985, C.D.M. Keating 419 & M.E. Trudgen (BM, MEL, PERTH); 29 Sep. 1998, S. van Leeuwen 4094 (AD, BRI, NSW, PERTH); 25 Sep. 1997, M.E. Trudgen 16000 (MEL, PERTH).

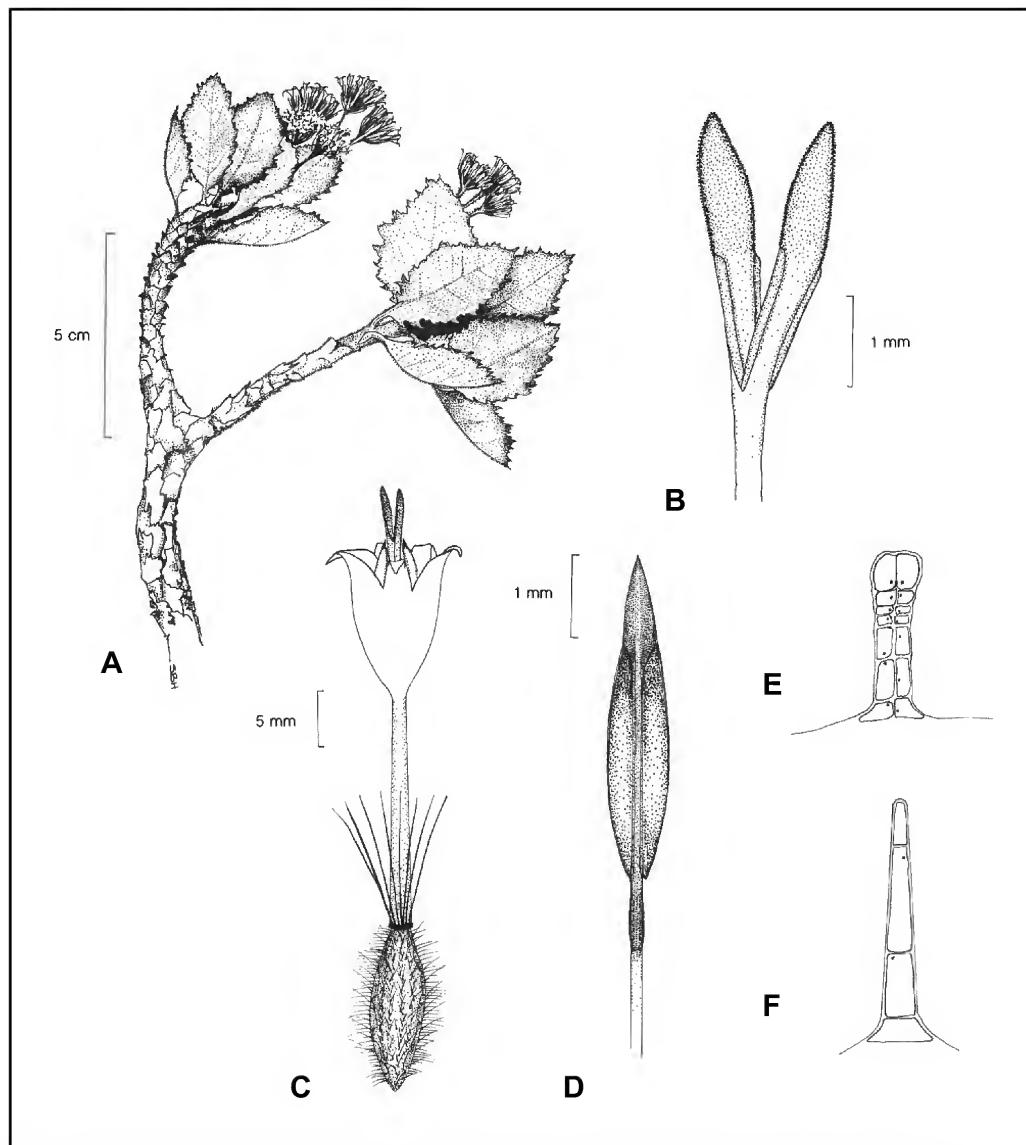


Figure 1. *Pilbara trudgenii*. A – flowering branchlet; B – stylar arms; C – tubular floret; D – anther; E – multicellular, biseriate, capitate, glandular hair; F – multicellular, uniseriate, simple eglandular hair. Scale bars = 5 cm (A); 1 mm (B); 5 mm (C); 1 mm (D). Drawn from C.D.M. Keating 411 & M.E. Trudgen (holo: PERTH).

*Flowering period.* October.

*Distribution.* Found in the southern central part of the Hamersley subregion (PIL3) of the Pilbara bioregion (PIL) in the Eremaean Botanical Province of Western Australia (Figure 3).

*Habitat.* In skeletal, red, stony soil on steep, scree slopes and in crevices on steep gully walls and cliff faces of massive banded ironstone amongst sparse subshrubs, tussock grasses and sedges (Figure 2). Thus *P. trudgenii* is an obligate lithophyte with little plasticity in its habitat preference of massive banded ironstone landforms.



Figure 2. *Pilbara trudgenii*. A – habitat and mature habit; B – juvenile habit; C – flowering head. Images: A – Stephen van Leeuwen (unvouchered); B, C – Emil Thoma (unvouchered).

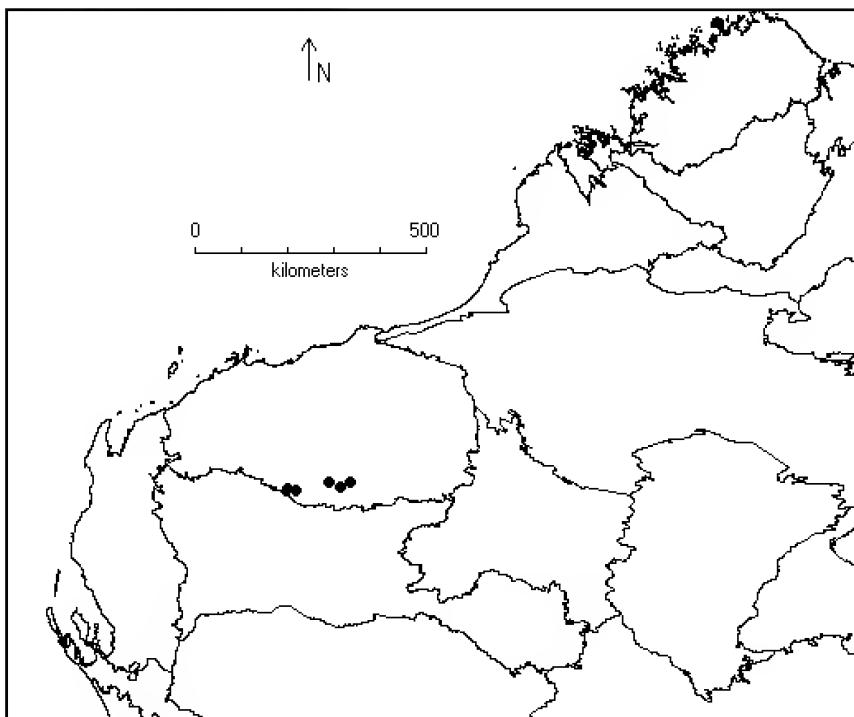


Figure 3. Distribution of *Pilbara trudgenii* in Western Australia.

**Conservation status.** Priority Two under the Department of Environment and Conservation's (DEC) Conservation Codes for Western Australian Flora (Smith 2012). This species is restricted to five small populations less than 130 km apart in an area where there are limited threats to its continued existence, although at least one population occurs within the footprint of a future iron ore mine. Two of the known populations are secure within Karijini National Park. At all sites combined there are at most only 160 individuals. It remains in need of further survey.

**Etymology.** The specific epithet honours botanist Malcolm Eric Trudgen (1951–), whose collections over many years have added so much to our knowledge of the flora of the Pilbara region. The Western Australian Herbarium currently holds over 8,300 of his specimens.

**Notes.** Other lithophytic species recorded in the Hamersley Range include *Astrotricha hamptonii* (Araliaceae), *Ptilotus mollis* (Amaranthaceae), *Olearia xerophila* (Asteraceae), *Pomax rupestris* (Rubiaceae), *Corymbia ferriticola* (Myrtaceae) and *Tetratheca fordiana* (Elaeocarpaceae).

## Discussion

Within the Astereae, a number of characters place *Pilbara* within the subtribe Grangeineae, notably its homomorphic, discoid heads, involucral bracts lacking resinous veins, ecaudate anther bases, style bases not broadened basally, style appendages ± equal in length to the stigmatic lines and papillose, and pappus (or pseudo-pappus) with a single series of bristles.

Within the Grangeinae, only two other genera share the paleate receptacles observed in *Pilbara*, namely the northern and western African *Ceruana* Forssk. and the Australian *Erodioiphllum* (Nesom & Robinson 2007: 304). The following diagnostic key will serve to distinguish these three genera.

1. Heads in cymbiform capitulescences with racemiform branches, disciform.  
Florets dimorphic: outer florets tubular, filiform, 4-lobed, estamine; inner florets tubular, hermaphrodite, 5-lobed. Receptacles flat. Pappus of short, basally connate, bristle-like scales or setae..... **Ceruana**
- 1: Heads solitary and terminal or in leafy, corymbiform capitulescences, radiate or discoid. Florets homomorphic (all tubular) or trimorphic (ligulate, reduced ligulate and tubular). Receptacles strongly convex to conical. Pappus of barbellate bristles or pseudopappus of minute, fused scales (pericarpic appendages)
  2. Perennial herbs. Leaves pinnatisect. Heads solitary, terminal, radiate.  
Florets trimorphic: ligulate (estamine), reduced ligulate (estamine) and 220–307 tubular (pseudo-hermaphrodite, functionally male). Involucral bracts 1–2-seriate; outer bracts becoming obdurate throughout or cartilaginous basally, fused basally and sometimes marginally, and reflexed, sometimes forming spiny horns. Receptacular paleae 6–7-seriate, subtending reduced ligulate and outer series of tubular florets. Sterile anther appendages deltoid. Pseudopappus of minute scales (pericarpic appendages) fused to form a short, lobed collar..... **Erodioiphllum**
  - 2: Shrubs. Leaves entire. Heads in leafy, corymbiform capitulescences, discoid. Florets homomorphic: 44–53, tubular (hermaphrodite). Involucral bracts 3–5-seriate, herbaceous throughout; outer bracts not forming spiny horns. Receptacular paleae subtending all florets. Sterile anther appendages triangular. Pappus of barbellate bristles..... **Pilbara**

Although they do not propose a new classification of the Astereae, Brouillet *et al.* (2009) present an ITS-based phylogeny of the tribe which identifies a number of lineages at variance with the classification of Nesom and Robinson (2007). In particular, they find the Grangeinae to be a monophyletic group of African and south Asian genera which does not include Australasian or American elements. Their analysis suggests a number of Australasian lineages, amongst them a lineage (4) which groups *Erodioiphllum* with *Calotis* R.Br., the latter placed in the subtribe Brachyscominae G.L.Nesom by Nesom and Robinson (2007). Both these genera have a base chromosome number of  $x=8$  (Watanabe *et al.* 1996, 2006) and both have achenes with a pseudopappus of pericarpic awns.

Vegetatively, *P. trudgenii* displays a superficial resemblance to *Olearia xerophila* (F.Muell.) Benth. (also a lithophyte, and found in the Pilbara region) from which it is readily distinguished by its paleate rather than epaleate receptacles and its discoid rather than radiate heads.

#### Acknowledgements

I am indebted to Malcolm Trudgen for first drawing this species to my attention and for his helpful observations and suggestions. I am grateful to Susan Harris for the illustration of *Pilbara trudgenii*. I thank Paul Wilson and Stephen van Leeuwen who both offered a number of useful comments on this paper, and Stephen van Leeuwen and Emil Thoma for providing the photographs.

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**SHORT COMMUNICATION****Review of infraspecific taxa in *Ptilotus gardneri* and *P. lophotrichus* and lectotypification of *P. conicus* (Amaranthaceae)**

This short communication is part of continued work aimed at revising *Ptilotus* R.Br. in Australia (e.g. Bean 2008; Lally & Barker 2010; Davis 2011; Palmer & Lally 2011), in preparation for the *Flora of Australia* treatment of Amaranthaceae. Two infraspecific taxa are synonymised (*P. gardneri* var. *inermis* Benl under *P. gardneri* Benl, and *P. lophotrichus* var. *villosus* Benl under *P. lophotrichus* Benl) and a lectotype is selected for *P. conicus* R.Br. Notes on similar species are also provided for *P. conicus*, *P. gardneri* and *P. lophotrichus*.

**Taxonomy**

***Ptilotus gardneri* Benl**, *Nuytsia* 2: 93–94 (1976). *Type*: ‘Western Australia Boundary Survey 1936–38, Lat. 17° 30' 5'', 10 June 1936, L. Stokes s.n. (*holo*: PERTH 01555103 n.v.).

*Ptilotus gardneri* var. *inermis* Benl, *Mitt. Bot. Staatssamml. München* 15: 165 (1979), *syn. nov.* *Type*: 12 miles north-west of Margaret River Crossing, Fossil Downs Station, Western Australia, 29 May 1967, J.R. Maconochie 286 (*holo*: M n.v.; *iso*: AD 97114239!, NT n.v.).

*Notes*. Benl (1979) distinguished *P. gardneri* var. *inermis* from the typical variety by its glabrous ovary and wider, less fimbriate lobes on the staminal cup. There is considerable variation in these characters and they are not sufficiently consistent or distinct to allow recognition of infraspecific taxa. Benl (*loc. cit.*) also indicated the occurrence of intermediates between the varietal taxa in *P. gardneri*.

*Ptilotus gardneri* is very similar to the more widespread and common *P. clementii* (Farmar) Benl. *Ptilotus gardneri* occurs just to the north of the distribution of *P. clementii* in northern Western Australia, in the Fitzroy Creek–Halls Creek–Turkey Creek area, extending into the Northern Territory at Mistake Creek. It has a grey-green aspect, stems and leaves with soft, dense, crisped, lanate hairs, and leaves with a cuneate or obtuse-truncate base. By contrast, *P. clementii* is usually green to dark green in aspect, and with hairs that while dense as in *P. gardneri*, are much coarser and are usually basally ‘thickened’. The leaves of *P. clementii* are basally attenuate, appearing petiolate. Inflorescences and perianths of both species are remarkably similar, although *P. gardneri* has shorter hairs on the lower half of the outer tepal surface, and the bracteoles are shorter than the bracts (they are more or less equal in *P. clementii*).

***Ptilotus lophotrichus* Benl**, *Trans. Roy. Soc. South Australia* 88: 56 (1964). *Type*: Arnhem Land, Northern Territory, 1928, H. Basedow 63 (*holo*: AD 96206050!; *iso*: K, image seen).

*Ptilotus lophotrichus* var. *villosus* Benl, *Muelleria* 5: 249 (1984), *syn. nov.* *Type*: near the Goyder River Crossing on the road to Gove, Arnhem Land, Northern Territory, 17 June 1972, D. Symon 7723 (*holo*: M n.v.; *iso*: AD 98593508! (ex ADW 40952)).

*Notes.* Benl (1964) described *P. lophotrichus* using the only collection known at the time. A second collection, D. Symon 7723, was initially regarded as being the same taxon by Benl (1984), and was subsequently described by him as *P. lophotrichus* var. *villosus*, again on the basis of a single collection. *Ptilotus lophotrichus* var. *villosus* was distinguished by its shorter bracts, bracteoles and tepals, and ‘straighter’ basal hairs on the tepals, which also extend further towards the median area of the tepal surface. With the benefit of subsequent collections, it has become apparent that there is a continuum in bract, bracteole and tepal size, shape and pubescence. Based on available material, the outer floral organs appear to decrease in size from west to east. The type of *P. lophotrichus* var. *villosus* represents the most easterly collection of this species.

Two very similar species, *P. comatus* Benl and *P. rotundatus* Benl, share their distribution in the far north of the Northern Territory with *P. lophotrichus*. All three species are low, perennial herbs with white or pale pink flowers and ovoid to cylindrical inflorescences, some of which are clustered terminally. Perianths (flowers) of all three have tepals with comose or dense tufts of hairs apically, and appressed, straight, crisped or bent hairs basally, with the remainder of the tepal glabrous. The style is central and all five stamens are fertile.

*Ptilotus rotundatus* is distinguished from both *P. comatus* and *P. lophotrichus* by its smaller perianths (1.7–2.2 mm long vs 2.5–4.3 mm) and shorter bracts, bracteoles, style and stamens. Tepals in *P. rotundatus* have rounded apices (vs acute or obtuse), and the apical hairs just exceed the apices (vs well exceeding the tepals, especially in *P. lophotrichus*). Inflorescences in *P. rotundatus* are usually slightly narrower (4–5 mm wide vs 5–10 mm wide) and, at 10–20 mm long, are a third to half the length of most inflorescences in *P. comatus* and *P. lophotrichus*.

*Ptilotus comatus* differs from *P. lophotrichus* and *P. rotundatus* in having bracts that are usually half or less than half the length of the bracteoles (vs more or less equal). *Ptilotus comatus* and *P. lophotrichus* are morphologically very similar, but may be further distinguished by differences in the hairs on the tepal apices. In *P. comatus*, the hairs are short, moderately dense and barely exceed the tepal apex, and are septate and clavate or rounded to more or less obtuse. In *P. lophotrichus*, the hairs are usually much longer and denser, exceeding the tepal apices by more than twice the hair length, and are nodose and acute.

***Ptilotus conicus* R.Br., *Prodr. Fl. Nov. Holland.* 415 (1810).**

*Trichinium conicum* (R.Br.) Spreng., *Syst. Veg.* 1: 816 (1825). Type: Carpenteria, Island p [Winchelsea Island, Northern Territory], 16 January 1803, R. Brown s.n., and Carpenteria, Point S [vicinity of Point Blane, Northern Territory], 28 January 1803, R. Brown Bennett No. 3056 (*lecto*, here chosen: BM 000895566 image seen). Syntypes: Gulf of Carpenteria, s. dat., R. Brown s.n. (MEL 074109A n.v.); Carpenteria, s. dat., R. Brown s.n. (BRIAQ 0332681, E 00279882, E 00279883, P 04944047, P 04944050, images seen for all); North Coast, s. dat., R. Brown s.n. (BM 000895568, image seen); Nov. Holland., s. dat., R. Brown s.n. (C 10005455, image seen).

*Ptilotus amabalis* Span., *Linnaea* 15: 345 (1841), nom. inval., nom. nud.

*Ptilotus conicus* var. *timorensis* Engl., *Bot. Jahrb. Syst.* 7: 454 (1886). Type: Atapupu, Timor, 29 May 1875, F.C. Naumann s.n. (holo: ?B n.v.).

*Notes.* Of the syntypes of *P. conicus*, BM 000895566 has been chosen as the lectotype as it is the largest

and most complete of the available original material seen by Brown and it bears labels in Brown's hand, with specific localities. One of Brown's labels is attached to a Bennett label numbered 3056, the other is attached directly on the sheet, but there is no indication as to which of the labels (with different locality information) relates to which of the four specimens on the sheet. Accordingly, all specimens on the sheet are considered to comprise the lectotype. As it is not clear whether the remaining type material is part of the same gathering as the lectotype, these collections are regarded as syntypes.

*Ptilotus conicus* is often confused with *P. corymbosus* R.Br. and *P. spicatus* F.Muell. ex Benth., with which it co-occurs. All have a similar herbaceous habit, usually with reddish stems and few linear or narrowly elliptic leaves. The perianths are also similar in all three taxa: 3.8–6.2 mm long, glabrous in the upper half, with five fertile stamens and a central style.

*Ptilotus conicus* is readily distinguished by its staminal filaments, which are flared apically just below the point of anther insertion, a character unique to this taxon. *Ptilotus conicus* differs further from *P. spicatus* in having shorter inflorescences (7–30 mm long vs (10–)25–70 mm), and an outer tepal surface with hairs attached basally and extending to near the middle of the tepal. *Ptilotus spicatus* has an outer tepal surface with hairs attached basally and either side of the ribs on the lower half (forming combs). The ovary in *P. conicus* is glabrous whereas it is apically hairy in *P. spicatus*.

*Ptilotus conicus* differs from *P. corymbosus* in having tepals of equal width for their entire length and with no discernible ribbing on their lower half (vs tepals that are broader in their upper half and with prominent ribbing in their lower half), and a glabrous ovary (vs hairy or apically hairy).

*Ptilotus corymbosus* can be distinguished from *P. spicatus* by its shorter inflorescences (5–24 mm long vs (10–)25–70 mm long in *P. spicatus*). The outer tepal surface in *P. corymbosus* is glabrous except for basally attached hairs, whereas *P. spicatus* has short hairs either side of the ribs in the lower part of the tepals, in addition to short, basally attached hairs.

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## Terena R. Lally

Australian National Herbarium, Centre for Plant Biodiversity Research,  
GPO Box 1600, Canberra, ACT 2601



## A taxonomic review of the *Solanum sturtianum* subgroup of subgenus *Leptostemonum* (Solanaceae)

**Anthony R. Bean**

Queensland Herbarium, Mt Coot-tha Road, Toowong, Queensland 4066  
Email: tony.bean@qld.gov.au

### Abstract

Bean, A.R. A taxonomic review of the *Solanum sturtianum* subgroup of subgenus *Leptostemonum* (Solanaceae). *Nuytsia* 23: 129–161 (2013). The informal taxonomic subgroup typified by *Solanum sturtianum* F.Muell. comprises those species that have stellate hairs, black mature fruits with a thin brittle pericarp, and brown to black seeds. The subgroup is endemic to Australia. Ten species are recognised here: *S. sturtianum* is maintained, *S. morrisonii* Domin is reinstated, and eight new species are described *viz.* *S. austropiceum* A.R.Bean, *S. elatus* A.R.Bean, *S. iodinum* A.R.Bean, *S. kentrocaule* A.R.Bean, *S. octonum* A.R.Bean, *S. piceum* A.R.Bean, *S. pycnotrichum* A.R.Bean and *S. reclusum* A.R.Bean. A lectotype is chosen for *S. morrisonii*. Descriptions, illustrations and distribution maps are provided for all species.

### Introduction

The first specimens of *Solanum sturtianum* F.Muell. were collected by the explorer Charles Sturt and his party while exploring far western New South Wales and adjacent parts of South Australia in 1844 and 1845, and the species was subsequently described by Ferdinand Mueller (Mueller 1854). A second related species, *S. morrisonii* Domin, was added by Domin (1929). This name was a *nomen novum* for the taxon previously named as *S. tetrandrum* var. *angustifolium* Morrison. Australian solanologist David Symon examined many specimens of *S. sturtianum* s. lat. Judging by his determination slips from the 1960s and 1970s, Symon accepted *S. morrisonii* for a time, but ultimately (Symon 1981) he regarded it as a synonym of *S. sturtianum* presumably because of perceived intergradation between it and typical *S. sturtianum*. Symon (*loc. cit.*) adopted a very broad circumscription for *S. sturtianum* in his revision of *Solanum* L. in Australia, but he did concede that *S. sturtianum* ‘is much more variable in western and north-western Australia than in its more easterly areas’.

A measure of the variability of *S. sturtianum* s. lat. in Western Australia is that there are numerous specimens for which the collector raised doubts about the identity, mainly by the name provided e.g. *Solanum* sp. aff. *sturtianum*, *Solanum* sp., *Solanum* sp. 1, *Solanum* sp. ‘clay plain’. From herbarium specimens received as *S. sturtianum*, the present author has identified ten taxa that are regarded as specifically distinct, including *S. morrisonii*. Eight species, *S. austropiceum* A.R.Bean, *S. elatus* A.R.Bean, *S. iodinum* A.R.Bean, *S. kentrocaule* A.R.Bean, *S. octonum* A.R.Bean, *S. piceum* A.R.Bean, *S. pycnotrichum* A.R.Bean and *S. reclusum* A.R.Bean, are newly named here. These new species are all endemic to Western Australia, and most are of relatively restricted occurrence.

*Solanum sturtianum* and its allies belong to the large subgenus *Leptostemonum* (Dunal) Bitter, and can be considered a subgroup of the *S. esuriæ* Lindl. group, which was defined by Bean (2004) as having a non-acrescent calyx, glabrous inner surface of the corolla, yellowish green to brown mature fruits, and stellate hairs of the upper leaf surface with 8–18 lateral rays. This definition needs slight modification, because some species described herein have clusters of hairs on the inner surface of the corolla, and all of the species formerly included under *S. sturtianum* have black mature fruits.

The *S. sturtianum* subgroup is readily defined by its fruit type. Mature fruits are always black and have a very thin, brittle pericarp. Furthermore the fruits are 1-locular, with the placenta confined to the central area of the fruit. Unilocular fruits are relatively common amongst the red-fruited *Solanum* species, but have not been recorded for other members of the *S. esuriæ* group. Other salient characters are listed below.

## Materials and methods

All relevant herbarium material from BRI, CANB and PERTH has been examined, as has a type specimen from MEL. Images of type specimens at E and BM have also been viewed. Some of the relevant taxa have been examined by the author in the field in Queensland and Western Australia. Species are arranged in perceived systematic order, based on their morphological characteristics. The species descriptions and terminology presented in this paper follow those of Bean (2004) and all data gathered during this study have been added to an existing DELTA (Dallwitz *et al.* 1993–) dataset, and interactive keys have been produced using IntKey (Dallwitz *et al.* 2000–; Spooner & Chapman 2007). All measurements are based on dried herbarium material. In the specimen citations, the abbreviation ‘HS’ is used for Homestead.

The distribution maps were compiled using DIVA-GIS Version 5.4.0.1, using data from the herbaria listed above.

## Morphology

### Prickles

The density of prickles (Figure 1A) varies greatly between taxa, and is quite variable within taxa. *Solanum kentrocaule* has more than 200 prickles per 0.1 m of stem length on the branchlets, and prickles are also present on the petioles, leaves, rachises and sometimes on the calyx. At the other extreme, *S. morrisonii* often has no prickles at all. The length and shape of the prickles is somewhat diagnostic: *S. elatius* has rather short, broad-based prickles; the prickles of *S. kentrocaule* and *S. austropiceum* are long and slender.

### Stellate hairs

Most of the taxa in the *S. sturtianum* subgroup are characterised by stellate hairs (Figure 2A–D) that have 11–16 lateral rays, and three species in the subgroup (*S. morrisonii*, *S. elatius* and *S. sturtianum*) have stellate hairs that lack a central ray. The stellate hairs of several other Australian *Solanum* species can have similarly high numbers of lateral rays (e.g. *S. coactiliferum* J.M.Black and *S. esuriæ*), and in some other species the stellate hairs lack a central ray (e.g. *S. corifolium* F.Muell. and *S. dimorphispinum* C.T.White), but the combination is unique to the *S. sturtianum* subgroup.

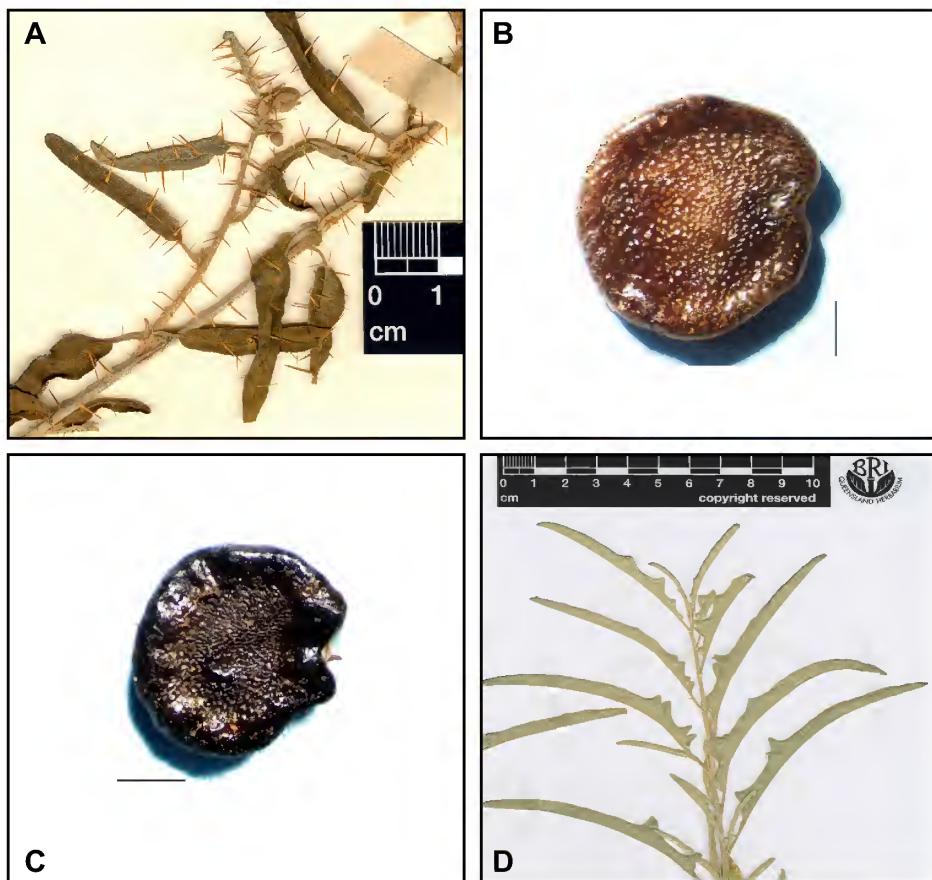


Figure 1. A – adult leaves and prickles of *Solanum piceum* (C.A. Gardner 4175); B – seed of *S. elatius* (A.A. Mitchell PRP 1239); C – seed of *S. austropiceum* (T.E. Aplin 2504); D – juvenile leaves of *S. elatius* (A.R. Bean 25314). Scale bars = 1 mm.

## Corolla

The corolla for the *S. sturtianum* subgroup is routinely mauve to purple in colour, although white-flowered plants can occur from time to time. The shape is predominantly rotate, but *S. sturtianum* can be shallowly lobed. The inner surface is glabrous for some species, while other species have a cluster of hairs (simple and/or few-branched) at the apex of each corolla lobe.

## Calyx

The calyx lobes of the *S. sturtianum* subgroup are short, deltate to semicircular, and not accrescent. Two adjacent lobes may sometimes be partly fused giving rise to an apparently 4-lobed calyx and differing lobe lengths. The calyx is mostly without prickles, but prickles do sometimes occur on the basal flowers of *S. kentrocaule* and *S. piceum*. In two species, the calyx lobes are violet, and there is a marked decrease in density of stellate hairs from the base of the calyx tube to the ends of the lobes; in all other species the calyx is white or yellowish, and the density of hairs is more or less uniform throughout.

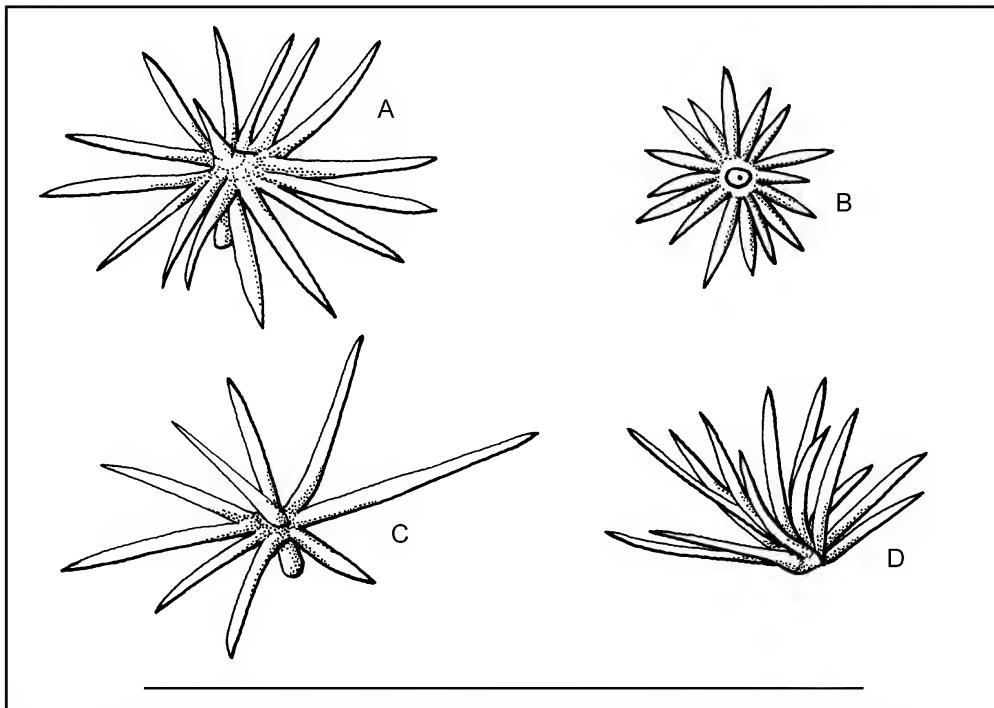


Figure 2. Stellate hairs of the lower leaf surface. A – *Solanum austropiceum*, oblique view (*A.A. Mitchell 1182*); B – *S. elatius*, plan view (*A.R. Bean 25314*); C – *S. pycnotrichum*, oblique view (*S. Dillon & A. Markey CR 9004*); D – *S. reclusum*, lateral view (*R.J. Cranfield 5640*). Scale bar = 1 mm.

## Fruits

The *S. sturtianum* subgroup is characterised by the fruits, which are black at maturity and have a thin, crustaceous pericarp. After maturity, the fruits remain attached to the pedicel. They become neither wrinkled nor bony, but tend to retain their globular shape, and then often break into fragments to release the seeds. This is especially evident on the herbarium sheet, where loose seeds, and pieces of placenta and pericarp are the end result; immature fruits remain whole and become lacunose upon drying out.

By contrast, the fruits of arid-zone species with a moderately thick pericarp (e.g. *S. centrale* J.M.Black) shrivel and become wrinkly after maturity; those with a very thick pericarp (e.g. *S. quadriloculatum* F.Muell.) do not shrivel much but become hard and bony.

## Seeds

The lenticular seeds (Figure 1B, C) are roughly circular in profile, and brown to black in colour. The surface for all species is alveolate due to the deflation of air-filled, surface-layer cells. Near the margin, the cells often remain inflated and the margin is then smooth and considerably thicker. The seeds are sometimes coated in a resinous material.

## Juvenile leaves

In many *Solanum* species, the leaves change in size and shape as the plant matures, and those produced by a young plant before and up to its first inflorescence are called juvenile leaves (Figure 1D). The form of these leaves is often highly diagnostic. Unfortunately, the juvenile leaves are rarely collected or noted by plant collectors, and they are known for only three members of the *S. sturtianum* subgroup, i.e. *S. sturtianum*, *S. morrisonii* and *S. elatus*. The juvenile leaves of the first two species mentioned are entire and of similar shape to the adult leaves, but those of *S. elatus* have two or three pairs of conspicuous obtuse lobes on the basal half of the leaves.

## Poisonous properties

As early as 1897 *S. sturtianum* was suspected as being poisonous to cattle. All doubt was removed when, in 1913, more than 1,000 sheep travelling in South Australia died after eating it, and there have been other instances of the death of cattle and sheep in New South Wales and Queensland (Hurst 1942; Everist 1974). The toxic agents in *S. sturtianum* are presumably the steroid glycoalkaloids that are known to be present. All parts of the plant are regarded as poisonous, with unripe fruits thought to be the most toxic part (McKenzie 2012).

It seems likely that all species in the subgroup are toxic. Aplin and Cannon (1971) reported a strongly positive result for the presence of alkaloids in *S. 'sturtianum'* collected near Onslow, Western Australia. Their voucher specimen (*T.E. Aplin* 1602, PERTH) is identified here as *S. morrisonii*.

## Taxonomy

### Description of *Solanum sturtianum* subgroup

Erect rhizomatous perennial shrubs. *Indumentum* of stellate hairs with lateral rays usually 11–16, central ray absent or present, the rays not gland-tipped; simple hairs absent; small glandular hairs absent from branchlets and leaves, sometimes present on style and ovary. *Adult branchlets* terete, prickles often present. *Adult leaves* entire or repand. *Inflorescence* supra-axillary, cymose (pseudo-racemose), andromonoecious. *Flowers* 5-merous (rarely 4-merous), basal flowers long-styled and bisexual, distal flowers short-styled and effectively male; calyx lobes deltate to semicircular, corolla mauve or purple (occasionally white), rotate; anthers all the same length; functional style not eccentric, protruding between anthers, straight or somewhat sinuate. *Fruiting calyx* not accrescent (less than half length of mature fruit). *Mature fruits* globular, black, dull or shiny, 1-locular (septum absent or incomplete); pericarp very thin and crustaceous, 0.1–0.2 mm thick; placenta sessile, linear; interior dry. *Fruiting pedicels* strongly recurved. *Seeds* brown to black, compressed, lenticular with the surface conspicuously alveolate, but thicker near the rim with a smooth surface.

*Size and distribution.* Ten species, all endemic to mainland Australia.

### Key to species in the *Solanum sturtianum* subgroup

1. Stellate hairs on upper and lower leaf surfaces multiradiate; central ray indistinguishable from lateral rays ..... **1. *S. reclusum***
- 1: Stellate hairs on leaves porrect; central ray absent or present, when present, easily distinguishable from lateral rays
  2. Prickles 200–1,000 per 0.1 m length of stem ..... **2. *S. kentrocaule***
  - 2: Prickles 0–56 per 0.1 m length of stem
    3. Most stellate hairs on leaves with 6–8 (predominantly 8) lateral rays
      4. Indumentum of upper leaf surface very sparse; central ray of stellate hairs on leaves 0.1–0.8 times as long as laterals; anthers 5.2–6.5 mm long ..... **3. *S. octonum***
      - 4: Indumentum of upper leaf surface dense to very dense; central ray of stellate hairs on leaves 1–2.5 times as long as laterals; anthers 7–7.3 mm long ..... **4. *S. pycnotrichum***
    - 3: All stellate hairs on leaves with 10–16 lateral rays
      5. Prickles present on at least some leaf laminae on each branch; stellate hairs of calyx with central ray 0.2–1 times as long as laterals; branchlet prickles acicular, (6–)9–18 times longer than wide
        6. Lower leaf surface white to grey, with dense to very dense indumentum of stellate hairs; ovary glabrous ..... **5. *S. austropiceum***
        - 6: Lower leaf surface green to grey-green, with very sparse to moderate stellate hairs; ovary with glandular hairs and sometimes also with stellate hairs
          7. Calyx lobes violet, with stellate indumentum very sparse to sparse, 0.1–0.2 mm diam.; stellate hairs of upper leaf surface with central ray 0.5–0.9 times as long as laterals ..... **6. *S. iodinum***
          - 7: Calyx lobes white to pale yellow, with indumentum of stellate hairs very dense, 0.25–0.3 mm diam.; stellate hairs of upper leaf surface with central ray 0–0.4 times as long as laterals ..... **7. *S. piceum***
        - 5: Prickles absent from all leaf laminae; stellate hairs on all plant parts lacking a central ray; branchlet prickles broad-based, 4–8 times longer than wide
          8. Leaf lamina 3.1–5.7 times longer than broad; branchlet stellate hairs 0.3–0.5 mm diam. ..... **8. *S. sturtianum***
          - 8: Leaf lamina 5.7–16 times longer than broad; branchlet stellate hairs 0.15–0.3 mm diam.
            9. Upper leaf surface very sparsely to sparsely hairy; style and ovary with small glandular hairs; small shrub 0.3–1 m high; stems usually without prickles; juvenile leaves entire ..... **9. *S. morrisonii***
            - 9: Upper leaf surface with moderate to very dense indumentum; style and ovary glabrous; large shrub to 2.5(–3) m high; stems usually sparsely prickly; juvenile leaves with conspicuous lobes (Figure 1D) ..... **10. *S. elatius***

### **1. *Solanum reclusum* A.R.Bean, sp. nov.**

Frutex indumento denso usque densissimo in pagina superiore folii; folia pilis multiradiatis stellatis praedita radio centrali longitudine radios laterales aequanti et non distinguibili et calycis indumentum variabile, ad basim tubi densissima usque sparsissima vel absenti ad apicibus loborum.

*Typus*: north-north-west of Meekatharra, Western Australia [precise locality withheld for conservation reasons], 12 August 1986, R.J. Cranfield 5640 (*holo*: PERTH 03699366; *iso*: CANB 380405).

Erect shrub c. 1 m high. Juvenile leaves unknown. Adult branchlets grey or brown, with a dense or very dense indumentum; prickles 5–10 per 0.1 m of stem, straight, broad-based, 1.5–7 mm long, 5–8 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs 0.25–0.4 mm diam., with a stalk 0–0.1 mm long and 8–12 ascending lateral rays, the central ray indistinguishable from laterals. Adult leaves lanceolate, entire; lamina 4.8–7.6 cm long, 1.6–2.2 cm wide, 2.8–4.3 times longer than broad, apex acute, base broadly cuneate, oblique part 0–3 mm long, obliqueness index 0–6 percent; petiole 0.5–0.8 cm long, 8–14% length of lamina, prickles absent or rarely present. Upper leaf surface grey, with a dense to very dense indumentum; prickles absent; stellate hairs distributed throughout, 0.05–0.15 mm apart, 0.25–0.5 mm across, with a stalk 0–0.2 mm long and with 8–13 ascending or multiradiate lateral rays, the central ray indistinguishable from laterals. Lower leaf surface white, grey or yellowish, with very dense indumentum; prickles absent; stellate hairs c. 0.05 mm apart, 0.25–0.5 mm diam., with a stalk 0–0.1 mm long and 8–13 ascending or multiradiate lateral rays, the central ray indistinguishable from laterals. Inflorescence 6–11-flowered, with common peduncle 4–10 mm long, rachis prickles absent. Pedicels at anthesis 3–5.5 mm long, prickles absent. Calyx indumentum very dense at base of tube, gradually becoming sparser towards lobe apices; tube at anthesis 2.5–4.5 mm long; lobes deltate to shortly attenuate, 0.5–1.5 mm long, dark purple; prickles absent; stellate hairs yellowish or rusty, 0.3–0.4 mm across, with a stalk 0–0.1 mm long and 9–13 lateral rays, the central ray indistinguishable from laterals. Corolla purple, 12–16 mm long, inner surface glabrous. Stamens with anthers 5.1–5.4 mm long; filaments smooth, c. 1.7 mm long. Ovary with small glandular hairs only; functional style c. 9 mm long, with stellate and small glandular hairs. Fruiting calyx without prickles. Intact mature fruits not seen. Fruiting pedicels c. 8 mm long. (Figures 2D, 3)

*Specimens examined*. Known only from the type collection.

*Distribution and habitat*. Recorded only from one locality north-north-west of Meekatharra (Figure 4). It was reportedly frequent on a quartz hill in open scrub, with the soil being red clayey sand.

*Phenology*. Flowers are recorded for August. Fruiting time is unknown.

*Conservation status*. To be listed as Priority One under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (M. Smith pers. comm.).

*Etymology*. From the Latin *reclusus* meaning ‘separated’, ‘removed’ or ‘secluded’. This is in reference to the geographical location of the type, remote from any major highway or town.

*Affinities*. The closest relative of *S. reclusum* is unknown. It differs from all other species of the *S. sturtianum* subgroup by the multiradiate stellate hairs of the leaves, where the central ray is indistinguishable from the lateral rays (Figure 2D). The indumentum of the upper leaf surface is dense to very dense, a feature shared with only *S. elatius*, *S. sturtianum* and *S. pycnotrichum*. The calyx

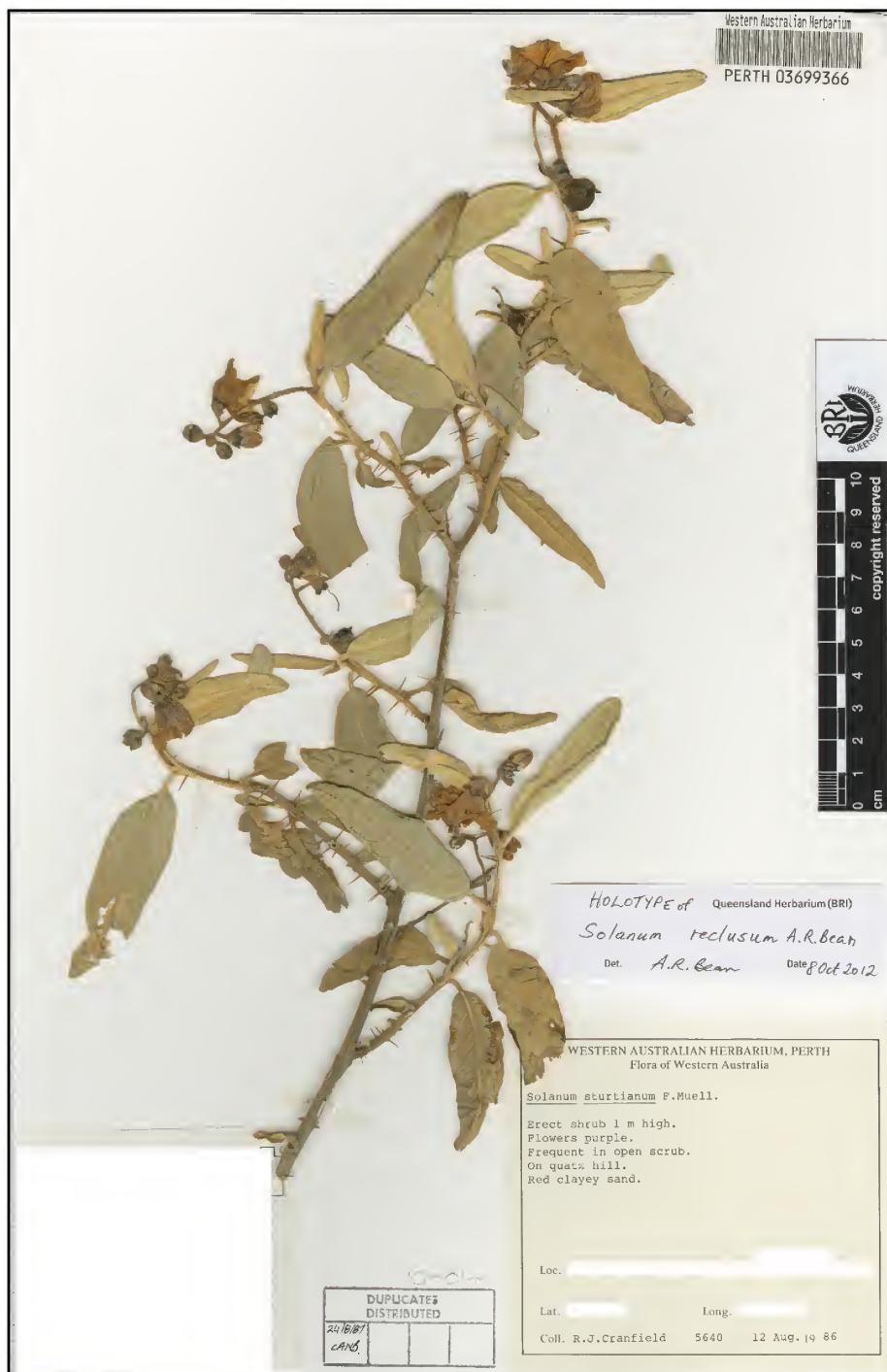


Figure 3. Holotype of *Solanum reclusum* (R.J. Cranfield 5640).

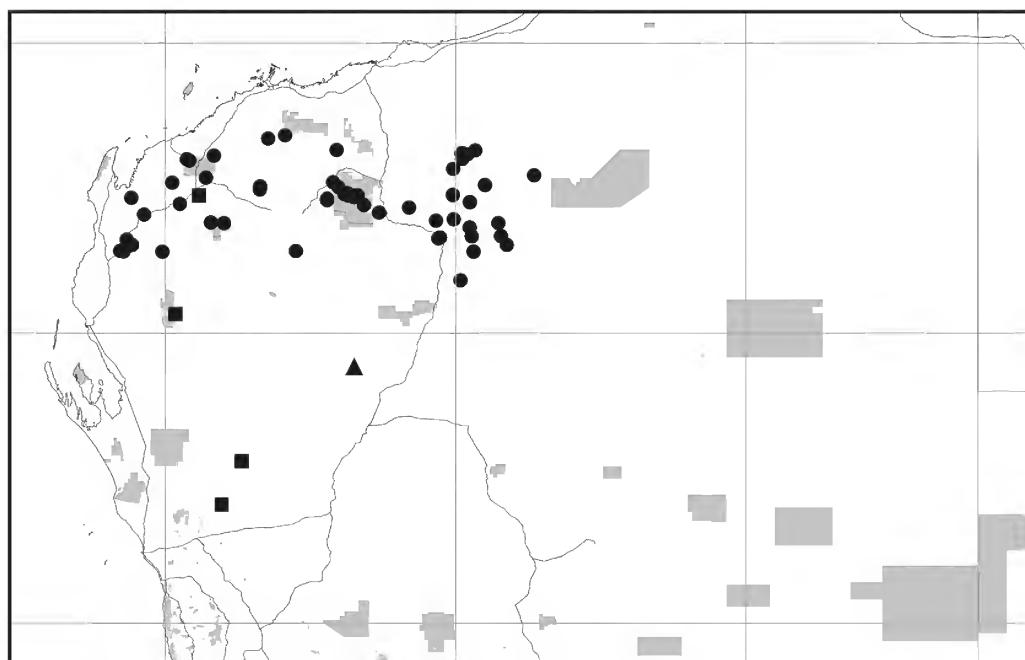


Figure 4. Distribution of *Solanum elatius* (●), *S. pycnotrichum* (■) and *S. reclusum* (▲).

indumentum varies from very dense at the base of the tube to very sparse or absent at the lobe apices; this feature occurs in only one other species in the subgroup, *S. iodinum*.

## 2. *Solanum kentrocaule* A.R.Bean, sp. nov.

Affinis *S. piceo* A.R.Bean sed caulibus aculeos in numero multo majore ferentibus, aculeis in pagina foliorum secus mesonervum et venam secundariam distributis, indumento sparso usque denso in pagina superiore foliorum, praesentia aculeorum superficie rhachis, inflorescentia 8–17-flora et seminibus minoribus absque margine tumido differens.

*Typus*: Tom Price, Western Australia [precise locality withheld for conservation reasons], 23 September 2006, D. Halford Q9247 (holo: BRI AQ742630; iso: PERTH, *distribuendi*).

*Solanum* sp. Gurinbiddy Range (M.E. Trudgen & M. Trudgen MET 12775), Western Australian Herbarium, in FloraBase, <http://florabase.dec.wa.gov.au> [accessed 30 September 2012].

*Shrub* 0.5–1.5 m high. *Juvenile leaves* unknown. *Adult branchlets* terete or ridged, white to yellow-brown, with a dense or very dense indumentum; prickles 200–1,000 per 0.1 m of stem, straight, acicular, 1.5–12 mm long, 9–18 times longer than wide, glabrous; stellate hairs 0.25–0.4 mm diam., with a stalk 0–0.1 mm long and 8–16 porrect or ascending lateral rays, the central ray 0.2–0.6 times as long as laterals. *Adult leaves* narrow lanceolate or lanceolate, entire or shallowly lobed throughout, lobes 3–5 on each side, obtuse, lobing index 1–1.1; lamina 3.5–12.5 cm long, 0.9–2 cm wide, 3.7–6.5 times longer than broad, apex acute, base cuneate or obtuse, oblique part 0–4 mm long, obliqueness index 0–6%; petiole 0.6–2.2 cm long, 14–22% length of lamina, prickles present. *Upper leaf surface* green or grey-green, with a sparse to dense indumentum; prickles present on midvein and lateral veins,

10–60, straight, acicular, 1.5–9 mm long; stellate hairs distributed throughout, 0.15–0.4 mm apart, 0.15–0.3 mm across, sessile, with 8–13 porrect lateral rays, the central ray 0.2–0.4 times as long as laterals. *Lower leaf surface* white or grey, with a moderate to very dense indumentum; prickles 40–70, present on midvein and lateral veins, straight, acicular; stellate hairs 0.1–0.3 mm apart, 0.2–0.4 mm diam., sessile, with 8–13 porrect lateral rays, the central ray 0.2–0.5 times as long as laterals. *Inflorescence* 8–17-flowered, with common peduncle 4–11 mm long, rachis prickles present. *Pedicels* at anthesis 2.5–9 mm long, prickles absent or present. *Calyx* with a very dense indumentum; tube at anthesis 2–3.5 mm long; lobes deltate, 1–3 mm long; prickles absent or rarely up to 5, 1–2.5 mm long; stellate hairs yellow, white or purple, 0.2–0.25 mm across, with a stalk 0–0.05 mm long and with 8–12 lateral rays, the central ray 0.4–0.7 times as long as laterals. *Corolla* mauve or purple, 13–17 mm long, inner surface glabrous throughout. *Stamens* with anthers 5–7.5 mm long; filaments smooth, 0.8–1.8 mm long. *Ovary* with small glandular hairs only; functional style 7–12 mm long, with small glandular hairs only. *Fruiting calyx* lobes around half length of mature fruit, prickles absent or present. *Mature fruits* 1–4 per inflorescence, c. 13 mm diam. Fruiting pedicels 6–9 mm long. *Seeds* 2.5–3 mm long; surface alveolate throughout, without a smooth swollen rim. (Figures 5, 6A, B)

*Specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 31 July 1980, K. Atkins 801 (PERTH); 7 Aug. 1995, B. Backhouse SR337 (PERTH); 14 Oct. 1968, J.V. Blockley 998 (PERTH); 5 Aug. 2008, G. Byrne 3533 (DNA, PERTH); 2 Sep. 2004, R.J. Chinnock 9698 (PERTH); 18 July 2007, T. Edwards AJ16-27 (PERTH); 2 Sep. 2004, W.K. Harris WKH2242 (BRI); 31 July 1986, S.D. Hopper 4984 (PERTH); 7 Aug. 1998, S. van Leeuwen 3710 (CANB, PERTH); 7 Aug. 1998, S. van Leeuwen 3744 (CANB, PERTH); 9 Sep. 1984, P.A. Wurm 1517 (PERTH).

*Distribution and habitat.* *Solanum kentrocaule* is endemic to Western Australia and has been found only in the Hamersley Range between 700 metres to 1,250 metres altitude (Figure 7). It inhabits hillsides and mountaintops, or occasionally creek-beds, in skeletal red-brown soil over ironstone or on basalt scree. Associated tree species include *Eucalyptus leucophloia* and *E. kingsmillii*.

*Phenology.* Flowers are recorded from July to October; fruits are recorded for September.

*Conservation status.* Recently listed as Priority Three under DEC Conservation Codes for Western Australian Flora, as *S. sp.* Gurinbiddy Range (M.E. Trudgen & M. Trudgen MET 12775) (Western Australian Herbarium 1998–).

*Etymology.* From the Greek *kentron* meaning ‘point’, ‘prickle’ or ‘goad’, and *caulos* meaning ‘stem’. This is in reference to the extremely prickly stems of this species.

*Affinities.* *Solanum kentrocaule* appears to be most closely related to *S. piceum*, but it differs from the latter by the far greater number of prickles on the branchlets, the greater number of prickles (10–60) on the upper leaf surface, the greater number of flowers per inflorescence, and by the seeds only 2.5–3 mm long and lacking a smooth swollen rim. *Solanum kentrocaule* can be distinguished from all other species of the *S. sturtianum* subgroup by the very prickly branchlet, with 200–1,000 prickles per decimetre.

*Notes.* The specimen from Capricorn Range (J.V. Blockley 998) is atypical because of the sparse indumentum on the leaves. It is somewhat disjunct from the main distribution of the species, and may represent a distinct taxon.



Figure 5. Holotype of *Solanum kentrocaule* (D. Halford Q 9247).



Figure 6. Flowering and fruiting plants in habitat. A – *Solanum kentrocaule*, whole plant (D. Halford Q 9247); B – *S. kentrocaule*, branch with flowers and immature fruits (D. Halford Q 9247); C – *S. pycnotrichum*, branch with flowers and immature fruits (S. Dillon & A. Markey CR 9004); D – *S. sturtianum*, portion of plant with flowers and immature fruits (A.R. Bean 30118); E – *S. morrisonii*, branch with flowers and immature fruits (A.R. Bean 25435); F – *S. elatius*, branches with flowers, immature and mature fruits (A.R. Bean 25314).

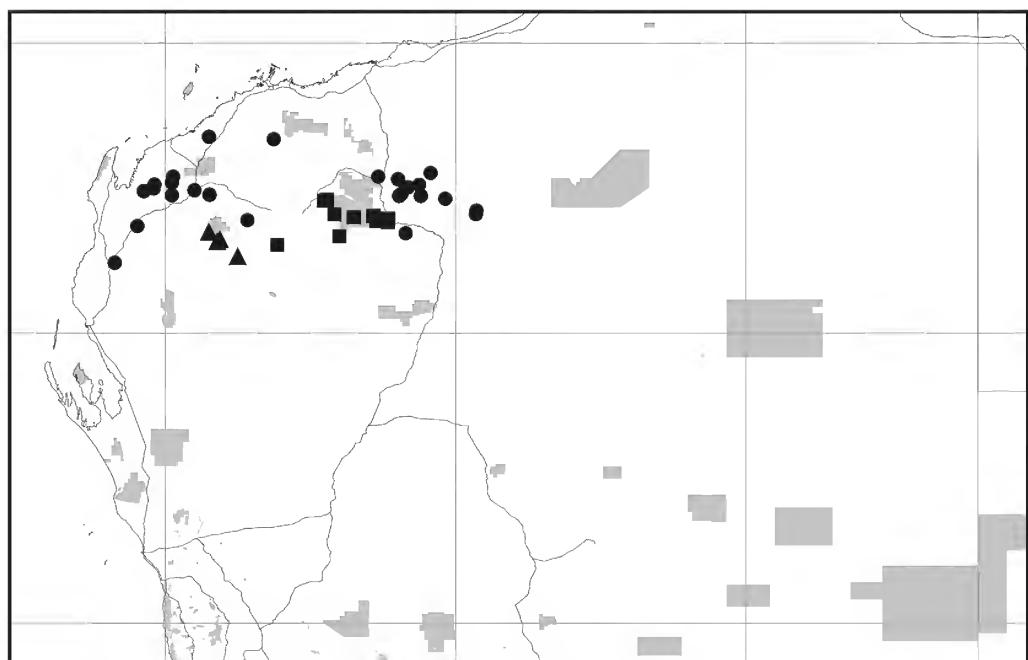


Figure 7. Distribution of *Solanum kentrocaule* (■), *S. morrisonii* (●) and *S. octonum* (▲).

### 3. *Solanum octonum* A.R.Bean, sp. nov.

Affinis *S. morrisonii* Domin sed numero majore aculeorum in quaque monade areae, in paginis foliorum pilis majoribusstellatis cum multis radiis 8 lateralibus praeditis, pilisstellatis calycis radium centralem distinctum ferentibus et pedicellis brioribus differens.

*Typus*: Barlee Range, Western Australia [precise locality withheld for conservation reasons], 18 August 1961, R.D. Royce 6559 (holo: PERTH 03753107).

Erect shrub 0.8–1.5 m high. Juvenile leaves unknown. Adult branchlets white to grey, with a very dense indumentum; prickles 10–56 per 0.1 m of stem, straight or curved, broad-based or acicular, 4–7 mm long, 5–12 times longer than wide, with scattered stellate hairs on lower half; stellate hairs 0.3–0.5 mm diam., with a stalk 0–0.1 mm long and with 8–15 porrect or ascending lateral rays, the central ray 0.2–0.8 times length of laterals. Adult leaves lanceolate, entire; lamina 5.9–8.0 cm long, 0.8–1.7 cm wide, 3.9–8 times longer than broad, apex obtuse, base cuneate, oblique part 0–7 mm long, obliqueness index 0–10%; petiole 0.5–1.6 cm long, 8–25% length of lamina, prickles present or absent. Upper leaf surface green, with a very sparse indumentum; prickles absent or present, 0–3 on midrib; stellate hairs distributed throughout, 0.4–0.6 mm apart, 0.2–0.4 mm across, sessile, with 6–12 porrect lateral rays, the central ray 0.1–0.8 times as long as laterals. Lower leaf surface green, with a sparse to dense indumentum; prickles absent or present, 0–1 on midrib; stellate hairs 0.15–0.4 mm apart, 0.25–0.5 mm diam., sessile, with 7–11 porrect lateral rays, the central ray 0.1–0.5 times as long as laterals. Inflorescence 6–13-flowered, with common peduncle 1–10 mm long, rachis prickles present or absent. Pedicels at anthesis 6–9 mm long, prickles absent. Calyx with a dense to very dense indumentum; tube at anthesis 2.5–3 mm long; lobes deltate, 2–3 mm long; prickles absent; stellate hairs

white or yellowish, 0.25–0.35 mm across, with a stalk 0–0.1 mm long and with 6–13 lateral rays, the central ray 0.5–1 times as long as laterals. *Corolla* purple, 12–15 mm long, inner surface glabrous or with a cluster of simple and branched hairs near lobe apices. *Stamens* with anthers 5.2–6.5 mm long; filaments smooth, 1.3–1.6 mm long. *Ovary* with small glandular hairs; functional style 8–9.5 mm long, with small glandular hairs. *Fruiting calyx* lobes less than half length of mature fruit, prickles absent. *Mature fruits* 1–4 per inflorescence, diam. unknown. *Fruiting pedicels* c. 8 mm long. *Seeds* not seen. (Figure 8)

*Specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: Sep. 1959, A. Robinson s.n. (PERTH); 5 Aug. 1993, S. van Leeuwen 1391 (PERTH); 12 June 1994, S. van Leeuwen 1714 (PERTH).

*Distribution and habitat.* Apparently restricted to the Barlee Range, in the Gascoyne bioregion of Western Australia (Figure 7). It is variously recorded from a gorge top, red sandy soil with *Triodia*, a steep hillslope with skeletal soil, and a riverine area with gritty sand.

*Phenology.* Flowers are recorded from June to September; mature fruits unknown.

*Conservation status.* To be listed as Priority Two under DEC Conservation Codes for Western Australian Flora (M. Smith pers. comm.).

*Etymology.* From the Latin *octonus*, ‘consisting of eight’. This refers to the stellate hairs of the leaves that are predominantly 8-rayed, in contrast to most species of the *S. sturtianum* subgroup.

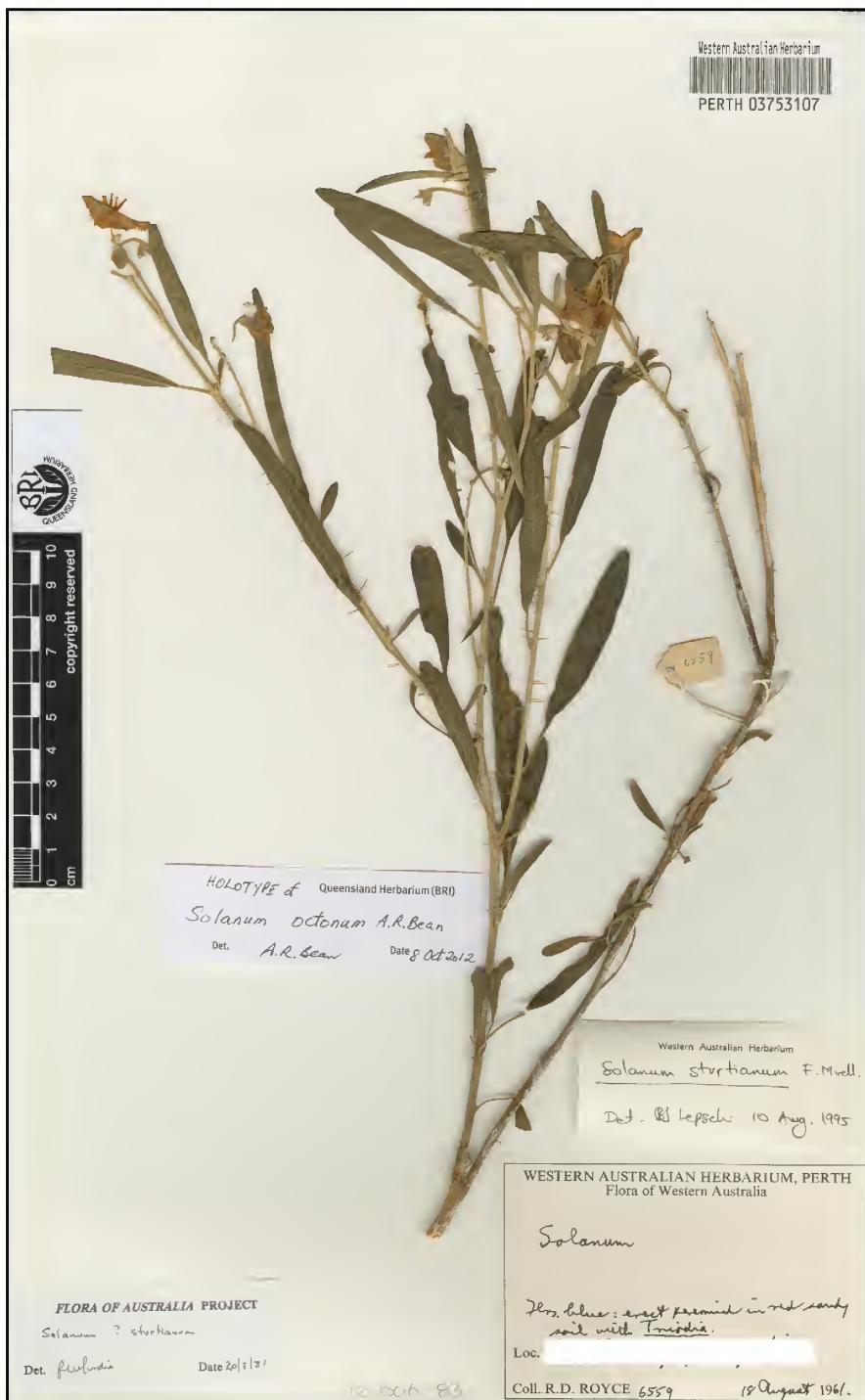
*Affinities.* *Solanum octonum* is similar in appearance to *S. morrisonii*, but differs from the latter by the larger stellate hairs on all plant parts, and by the stellate hairs having a distinct central ray and fewer lateral rays (typically eight). It differs from *S. pycnotrichum*, the other species having stellate hairs with ± eight lateral rays, by its much sparser indumentum, shorter central ray on the stellate hairs, and shorter anthers.

#### 4. *Solanum pycnotrichum* A.R.Bean, sp. nov.

A *S. sturtiano* F.Muell. pilis majoribus stellatis in partibus totis plantae, pilis radiis centralibus 6–8 et radio centrali longo praeditis, antheris longioribus et numero majore florum in inflorescentia differens.

*Typus:* south-south-east of Onslow, Western Australia [precise locality withheld for conservation reasons], 27 June 2011, S. Dillon & A. Markey CR 9004 (*holo*: BRIAQ875862; *iso*: PERTH 08338361).

Erect shrub 1.1–1.8 m high. *Juvenile leaves* unknown. *Adult branchlets* white to pale yellow, with a very dense indumentum; prickles 10–32 per 0.1 m of stem, straight, broad-based or acicular, 2–10 mm long, 7–14 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs 0.5–0.7 mm diam., with a stalk 0–0.4 mm long and with 8 ascending lateral rays, the central ray 1–2.2 times length of laterals. *Adult leaves* lanceolate to narrowly ovate, entire or repand; lamina 4.8–9.0 cm long, 1.6–3.4 cm wide, 2.6–4.5 times longer than broad, apex acute or obtuse, base obtuse or cuneate, oblique part 0–2 mm long, obliqueness index 0–3%; petiole 0.5–0.9 cm long, 6–18% length of lamina, prickles absent. *Upper leaf surface* grey-green to grey, with a dense to very dense indumentum; prickles absent; stellate hairs distributed throughout, 0.05–0.2 mm apart, 0.35–0.6 mm

Figure 8. Holotype of *Solanum octonum* (R.D. Royce 6559).

across, sessile, with 6–8 porrect lateral rays, the central ray 1–2.5 times as long as laterals. *Lower leaf surface* white or grey, with a dense to very dense indumentum; prickles absent; stellate hairs 0.05–0.1 mm apart, 0.4–0.6 mm diam., with a stalk 0–0.2 mm long and with 6–8 porrect lateral rays, the central ray 1–2 times as long as laterals. *Inflorescence* 8–29-flowered, with common peduncle 5–18 mm long, rachis prickles present or absent. *Pedicels* at anthesis 5–6 mm long, prickles absent. *Calyx* with a dense to very dense indumentum; tube at anthesis 2–3 mm long; lobes deltate, 1.5–2.5 mm long; prickles absent; stellate hairs yellowish, 0.3–0.5 mm across, with a stalk 0–0.1 mm long and 8 lateral rays, the central ray 1.2–2 times as long as laterals. *Corolla* purple, c. 13 mm long, inner surface glabrous or with cluster of simple hairs near lobe apices. *Stamens* with anthers 7.0–7.3 mm long; filaments smooth, c. 1.7 mm long. *Ovary* with small glandular hairs; functional style c. 10.5 mm long, with small glandular hairs. *Fruiting calyx* lobes less than half length of mature fruit, prickles absent. *Mature fruits* 2–4 per inflorescence, c. 15 mm diam. *Fruiting pedicels* 9–12 mm long. *Seeds* 3.2–3.4 mm long; surface alveolate throughout, without a smooth swollen rim. (Figures 2C, 6C, 9)

*Specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 23 Aug. 1931, C.A. Gardner & W.E. Blackall 512 (PERTH); 27 Aug. 2008, R. Meissner & J. Wright 2083 (PERTH); 19 Aug. 1987, K. Newbey 11610 (PERTH).

*Distribution and habitat.* The species has a scattered occurrence near the west coast of Western Australia, from Cane River Conservation Park in the north, to Mullewa in the south (Figure 4). On rocky sites, often drainage lines, with siltstone or banded ironstone in shrubland. Various *Acacia* spp. are dominant, also present in some places are *Solanum lasiophyllum*, *Eremophila latrobei* and *Ptilotus obovatus*.

*Phenology.* Flowers and fruits have been recorded in June and August.

*Conservation status.* To be listed as Priority Two under DEC Conservation Codes for Western Australian Flora (M. Smith pers. comm.).

*Etymology.* From the Greek *pyknos* meaning ‘thick’ or ‘dense’, and *trichos* meaning ‘hair’. The leaves of this species have very dense and thick stellate hairs.

*Affinities.* *Solanum pycnotrichum* has no obvious close affinity with others in the subgroup. It is the only species having stellate hairs in which the central ray consistently exceeds the lateral rays in length. The lateral rays number 6–8, and of the other subgroup members, only *S. octonum* has so few. Its short petioles are also a notable feature, as is the long rachis with many flowers.

##### 5. *Solanum austropiceum* A.R.Bean, sp. nov.

Affinis *S. piceo* A.R.Bean sed aculeis minus frequentibus in pagina folii, absentia loborum in foliis adultis, indumento moderate denso usque densissimo in pagina inferiore folii, calycis pilis stellatis radio centrali radiis lateralibus 0.3–1 longiore praeditis et ovario glabro differens.

*Typus:* 39 miles south of Old Mundiwindi, Western Australia, 22 August 1960, A.S. George 958 (*holo*: BRI AQ875922; *iso*: PERTH 03699285).

Erect shrub 0.4–1.2 m high. Juvenile leaves unknown. Adult branchlets white or grey, with a very dense indumentum; prickles present, 6–22 per 0.1 m of stem, straight, acicular, 3–9 mm long, 10–15 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs 0.4–0.6 mm



Figure 9. Holotype of *Solanum pycnotrichum* (S. Dillon & A. Markey CR 9004).

diam., sessile, with 12–16 porrect lateral rays, the central ray 0.1–0.6 times as long as laterals. *Adult leaves* lanceolate or elliptical, entire; lamina 3.5–8.0 cm long, 0.8–1.5 cm wide, 4.1–6.1 times longer than broad, apex obtuse or acute, base cuneate or obtuse; oblique part 0–8 mm long, obliqueness index 0–14%; petiole 0.5–2.1 cm long, 11–37% length of lamina, prickles absent or present. *Upper leaf surface* green to grey-green, with indumentum absent, or very sparse to sparse; prickles absent or present on midrib; stellate hairs 0.3–2.0 mm apart, 0.25–0.4 mm across, sessile, with 11–16 porrect lateral rays, the central ray 0.1–0.4 times as long as laterals. *Lower leaf surface* white or grey, with a moderate to very dense indumentum; prickles absent or present on midrib; stellate hairs 0.05–0.3 mm apart, (0.25–)0.3–0.6 mm diam., sessile, with 11–16 porrect lateral rays, the central ray 0.1–0.7 times as long as laterals. *Inflorescence* 4–11-flowered, with common peduncle 0–4 mm long, rachis prickles absent. *Pedicels* at anthesis 5–10 mm long, prickles absent. *Calyx* with a dense to very dense indumentum; tube at anthesis 1.5–2.5 mm long; lobes 2.0–3.0 mm long; prickles absent; stellate hairs yellow or white, 0.25–0.35 mm across, sessile, with 8–16 lateral rays, the central ray 0.3–1 times as long as laterals. *Corolla* purple, 10–15 mm long, inner surface glabrous. *Stamens* with anthers 3.8–6.0 mm long; filaments papillose, c. 1.5 mm long. *Ovary* glabrous; functional style 8–9 mm long, glabrous or with short glandular hairs and stellate hairs. *Mature fruits* 1 or 2 per inflorescence, 11–15 mm diam., black, shiny. *Fruiting pedicels* 7–11 mm long. *Seeds* 3.5–4.2 mm long. (Figures 1C, 2A, 10)

*Selected specimens examined.* WESTERN AUSTRALIA: Pollele Station, 1 Apr. 1962, *Anon.* (PERTH); 6 miles S of Moorarie HS on road to Meekatharra, 24 Aug. 1963, *T.E. Aplin* 2504 (PERTH); Wongawol Station, July 1941, *F.M. Bennett* 116 (PERTH); Glenorn Station near Morgans, 19 Aug. 1938, *N.T. Burbidge* 195 (PERTH); Patience Well area, Gibson Desert, 5 May 2001, *C.P. Campbell* 1961 (PERTH); Moorarie Station, via Meekatharra, 25 Aug. 1963, *J.R. Cannon* JRC 630818 (PERTH); 4.8 km SSE of Winderabbe Well, 4.8 km W of Erraninnie Well, Beringarra Station, 22 Apr. 1986, *R.J. Cranfield* 5304 (PERTH); Muthawyne Well, Moorarie Station, 25 Aug. 1986, *R.J. Cranfield* 5912 (PERTH); Corymbia camp, near Yallum Well on Carnegie Station, 23 Apr. 2002, *D.J. Edinger et al.* DJE 3160 (PERTH); 114.4 miles from Carnegie Station towards Mt Everard, 27 July 1966, *A.R. Fairall* 2030 (PERTH); Mt Margaret, 11 Aug. 1931, *C.A. Gardner & W.E. Blackall* 431 (PERTH); 28 miles [45 km] N of Warburton Mission, 24 July 1963, *A.S. George* 5308 (PERTH); Belele Station, 56 km WNW of Meekatharra, 20 Aug. 1965, *D.W. Goodall* 3027 (PERTH); Giles, 580 km WSW of Alice Springs, 8 July 1958, *R. Hill & T.R. Lothian* 889 (PERTH); 17 km N of Serpents Glen, Carnarvon Range, Little Sandy Desert, 5 Aug. 2001, *K.F. Kenneally & D.J. Edinger* 12201 (PERTH); 20 km W of Three Rivers HS, 20 Dec. 1983, *A.A. Mitchell* 1182 (PERTH); Pollele Station, 4 Apr. 1987, *A.L. Payne* 308 (PERTH); Mt Morgan mine, 23 July 1988, *H. Pringle* 2064 (PERTH); 2.2 km W of 7978, Lights of London paddock, Mount Weld Station, 22 July 1989, *H. Pringle* 2459 (PERTH); Lake Carey, c. 1 km NW from Mt Margaret trig on track to edge of lake, 15 Mar. 2004, *L.S. Sweedman* 6365 (PERTH).

*Distribution and habitat.* *Solanum austropiceum* is, on current knowledge, endemic to Western Australia, extending from Mt Augustus in the west to Giles in the east, and from Newman in the north to as far south as Leonora (Figure 11). It is often associated with Mulga (*Acacia aneura*) communities on plains, low hills or creekbanks, while the soil varies from red clayey loam to sand or laterite.

*Phenology.* Flowers are recorded from March to August; fruits are recorded from April to December.

*Conservation status.* A common species with a wide distribution, including occurrences in National Parks or conservation reserves.

*Etymology.* The epithet alludes to the fact that this species has a more southerly distribution than the related *S. piceum*; from the Latin *austro-* meaning ‘southern’.

Figure 10. Isotype of *Solanum austropiceum* (A.S. George 958).

*Affinities.* *Solanum austropiceum* is clearly related to *S. piceum*, but it differs from the latter by the strongly discolorous leaves (lower surface with moderately dense to very dense indumentum), prickles borne on only some of the leaves of a given branch, the glabrous ovary, and the often greater relative length of the central ray of the stellate hairs. *Solanum austropiceum* has consistently entire leaves, whereas *S. piceum* frequently has shallow irregular lobes, and sometimes hastate bases.

## 6. *Solanum iodinum* A.R.Bean, sp. nov.

Affinis *S. piceo* A.R.Bean sed pilis stellatis in pagina superiore folii radio centrali radiis lateralibus 0.5–0.9 longiore praeditis, calycis lobis violaceis ferentibus indumentum sparsissimum usque sparsum pilorum stellatorum, calycis pilis stellatis minoribus et pedicellis saepe longioribus differens.

*Typus:* Mount Padbury Station, Western Australia [precise locality withheld for conservation reasons], 15 August 1986, R.J. Cranfield 5709 (*holo*: PERTH 03699455; *iso*: CANB 380509).

Erect shrub c. 0.5 m high. *Juvenile leaves* unknown. *Adult branchlets* brown to violet, with a very dense indumentum; prickles present, 3–10 per 0.1 m of stem, straight, acicular, 4.5–8 mm long, 9–11 times longer than wide, glabrous or with stellate hairs at base; stellate hairs 0.35–0.5 mm diam., stalks absent, with 11–16 porrect lateral rays, the central ray 0.4–0.6 times as long as laterals. *Adult leaves* lanceolate or elliptical, entire; lamina 2.0–5.7 cm long, 0.6–1.3 cm wide, 2.6–4.4 times longer than broad, apex obtuse, base cuneate or obtuse; oblique part 0–1.5 mm long, obliqueness index 0–4%; petiole 0.4–1.0 cm long, 17–23% length of lamina, prickles absent or present. *Upper leaf surface* green, with indumentum absent or very sparse, 1 or 2 prickles present on midrib; stellate hairs 1.5–4.0 mm apart, 0.25–0.35 mm across, sessile, with 8–16 porrect lateral rays, the central ray 0.5–0.9 times as long as laterals. *Lower leaf surface* green to grey-green, with very sparse to dense indumentum; prickles absent or 1 or 2 present on midrib only; stellate hairs 0.2–0.6 mm apart, 0.3–0.45 mm diam., sessile, with 11–16 porrect lateral rays, the central ray 0.2–1.2 times as long as laterals. *Inflorescence* 4–7-flowered, with common peduncle 0–9 mm long, rachis prickles present or absent. *Pedicels* at anthesis 7–16 mm long, prickles present or absent. *Calyx* indumentum dense at base of tube, gradually becoming sparser towards lobe tips; tube at anthesis 2.0–2.5 mm long; lobes 2.0–3.0 mm long, purple; prickles absent; stellate hairs yellow or purple, 0.1–0.2 mm across, sessile, with 6–16 lateral rays, the central ray 0.4–1 times as long as laterals. *Corolla* purple to mauve, 13–16 mm long, inner surface glabrous. *Stamens* with anthers 5.8–6.1 mm long; filaments papillose, 1.6–2.2 mm long. *Ovary* with small glandular hairs only; functional style 9–10 mm long, with glandular hairs only. *Mature fruits* 1 per inflorescence, diam. unknown. *Fruiting pedicels* c. 8 mm long. *Seeds* 3.5–3.7 mm long. (Figure 12)

*Other specimen examined.* WESTERN AUSTRALIA [locality withheld for conservation reasons]: 12 Aug. 1986, R.J. Cranfield 5639 (CANB, PERTH).

*Distribution and habitat.* Known only from Mount Padbury station, c. 120 km north-north-west of Meekatharra in Western Australia (Figure 11). It grows in ‘open scrub’ on red or brown clayey sand.

*Phenology.* Flowers are recorded for August; fruiting time unknown.

*Conservation status.* To be listed as Priority One under DEC Conservation Codes for Western Australian Flora (M. Smith pers. comm.).

*Etymology.* The epithet is from the Greek word *iodes* meaning ‘violet-like’. This refers to the calyx lobes that are a rich violet colour in this species.

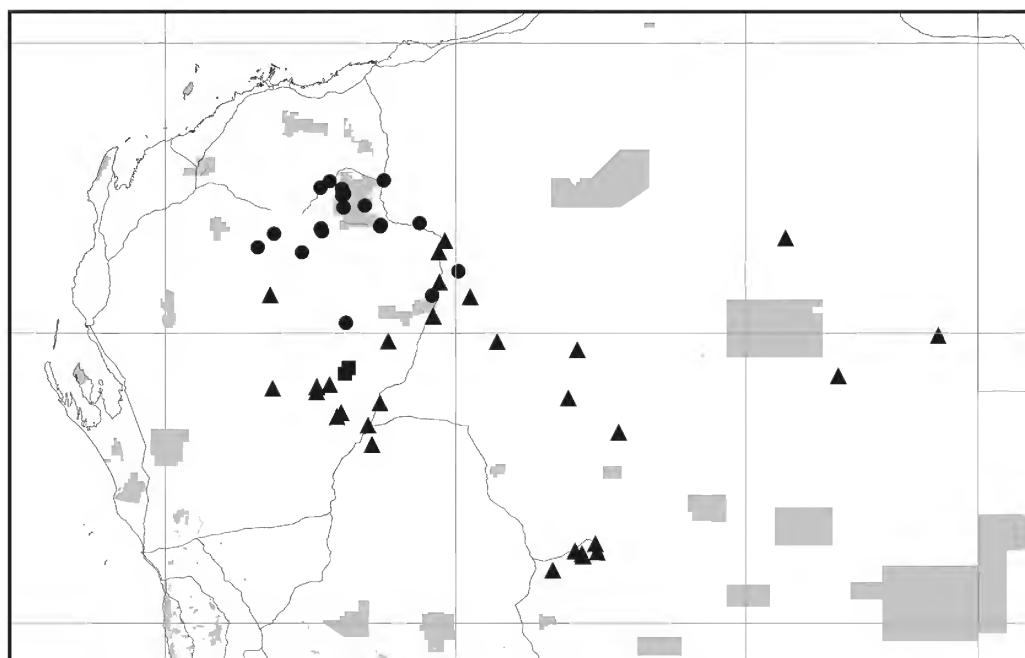


Figure 11. Distribution of *Solanum austropiceum* (▲), *S. iodinum* (■) and *S. piceum* (●).

**Affinities.** Related to *S. piceum*, but differing by the longer central ray of the stellate hairs on the upper and lower leaf surfaces and on the calyx, the mostly longer pedicels, the smaller stellate hairs on the calyx, the very sparse indumentum on the calyx lobes which are a rich violet colour, and the smaller seeds.

#### 7. *Solanum piceum* A.R.Bean, sp. nov.

Affinis *S. morrisonii* Domin sed numero majore aculeorum in ramulis, praesentia aculeorum in lamina foliorum, pilis stellatis in paginis omnibus foliorum calycisque, pilis stellatis calycis radio centrali praeditis differens.

**Typus:** Hamersley Station, 2 miles [3 km] east of 150 mile camp on the Mt Tom Price iron ore railway, Western Australia, 28 January 1976, M.E. Trudgen 1615 (*holo*: BRI AQ875923; *iso*: CANB, *distribuendi*, PERTH 06093388).

Erect shrub 0.6–1.5 m high. Juvenile leaves unknown. Adult branchlets white, brown or grey, with a very dense indumentum; prickles present, 6–27 per 0.1 m of stem, straight, acicular, 2–6 mm long, 6–18 times longer than wide, glabrous; stellate hairs 0.25–0.4 mm diam., sessile, with 10–15 porrect lateral rays, the central ray 0–0.7 times as long as laterals. Adult leaves linear, lanceolate or elliptical, entire or shallowly lobed, lobes 1–3 on both sides, lobing index 1–1.1; lamina 1.0–7.0 cm long, 0.3–1.9 cm wide, 3.2–11.8 times longer than broad, apex obtuse or acute, base cuneate or rarely hastate; oblique part 0–1 mm long, obliqueness index 0–4%; petiole 0.2–1.4 cm long, 12–21% length of lamina, prickles absent or present. Upper leaf surface green, with an absent or very sparse indumentum; prickles 1–5 on midrib; stellate hairs 0.5–3.0 mm apart, 0.25–0.35 mm across, sessile, with 10–16 porrect lateral

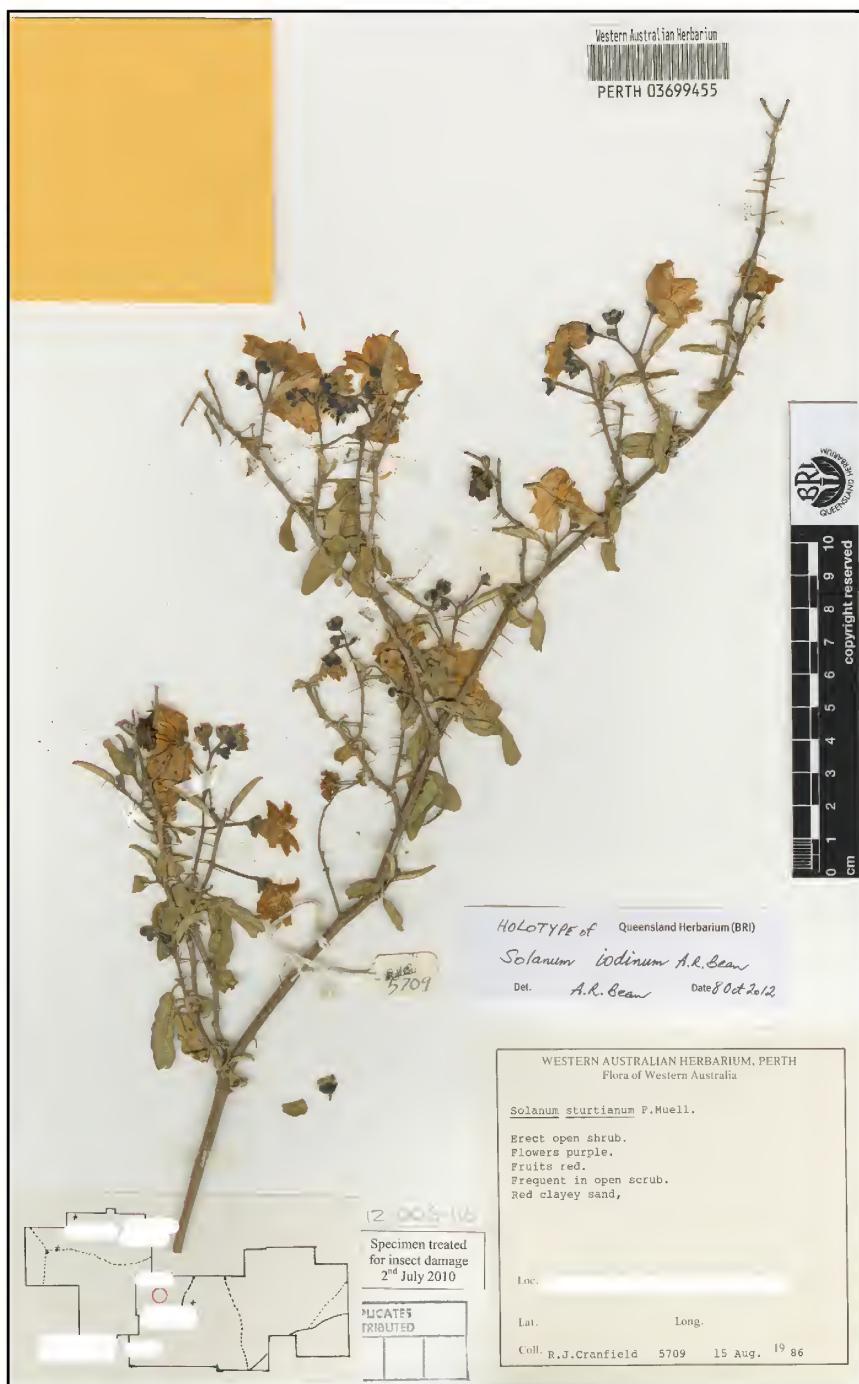


Figure 12. Holotype of *Solanum iodinum* (R.J. Cranfield 5709).

rays, the central ray 0–0.4 times as long as laterals. *Lower leaf surface* green to grey-green, with a very sparse to moderately dense indumentum; prickles 1–15 on midrib only, or on midrib and secondary veins; stellate hairs 0.15–0.8 mm apart, 0.25–0.4 mm diam., sessile, with 10–16 porrect lateral rays, the central ray 0–0.4 times as long as laterals. *Inflorescence* 2–8-flowered, with common peduncle 0–6 mm long, rachis prickles absent. *Pedicels* at anthesis 4–10 mm long, prickles present or absent. *Calyx* with a dense to very dense indumentum; tube at anthesis 1.5–2.5 mm long; lobes 0.5–2.5 mm long; prickles present or absent; stellate hairs yellow or white, 0.2–0.3 mm across, with a stalk 0–0.1 mm long and 11–16 lateral rays, the central ray 0.2–0.5 times as long as laterals. *Corolla* purple, 9–14 mm long, inner surface glabrous or with a cluster of simple hairs at the lobe apices. *Stamens* with anthers 4.7–6.4 mm long; filaments papillose, 1.5–2.0 mm long. *Ovary* with small glandular hairs only, or with small glandular hairs and stellate hairs; functional style 8–9.5 mm long, with glandular hairs only, or with short glandular hairs and stellate hairs. *Mature fruits* 1–6 per inflorescence, 13–16 mm diam., black, shiny. *Fruiting pedicels* 6–12 mm long. *Seeds* 3.8–4.5 mm long. (Figures 1A, 13)

*Selected specimens examined.* WESTERN AUSTRALIA: Ilgarari Station, holding paddock, 27 May 1996, Anon. 6/96 (PERTH); Paraburadoo, 5 May 1978, K.J. Atkins 236 (PERTH); near Mt Stevenson, Hamersley Range, 13 June 1966, J.V. Blockley 275 (PERTH); eastern Hamersley Range, 6 Sep. 1995, N.E. Casson & E.M. Mattiske MCPL 1022 (PERTH); 33.9 km N of Pretty Pool, Wanna Station, 24 June 2005, D.J. Edinger 5089 (PERTH); bed of Hardie River, Hamersley Range, 26 Aug. 1932, C.A. Gardner 4175 (PERTH); West Angelas, 24 Dec. 1975, S. Janicke U 16 (PERTH); south side of Paraburadoo Mine dump, 14 June 1977, A.A. Mitchell 384 (PERTH); 30 km W of Mininer Station HS, 21 July 1977, A.A. Mitchell 391 (BRI, PERTH); 40 km N of Mininer Station HS, 26 June 1977, A.A. Mitchell 404 (PERTH); Woodlands Station, 24 Mar. 1982, A.A. Mitchell 956 (PERTH); c. 17 km SE of Hamersley Station HS, 3 June 1994, A.A. Mitchell 3605 (BRI, PERTH); 24.6 km from Hamersley Station HS on a bearing of 186 degrees, and about 1.5 km S of Francis Bore near Witteenoom, 19 May 1996, A.A. Mitchell PRP 1114 (PERTH); 12 km from Weelarrana HS on a bearing of 26 degrees, near Newman, 19 June 1996, A.A. Mitchell PRP 1150 (PERTH); c. 23 km E of Ashburton Downs Station HS, 1 km S of the Ashburton Downs–Kooline River road, c. 100 km SW of Paraburadoo, 12 May 1997, A.A. Mitchell 4727 (PERTH); 4.0 km SW of West Angelas camp, 29.5 km due S of Packsaddle Camp, 13 Feb. 1987, F.H. Mollemans 2259 (PERTH); 14 km N of Juna Downs HS, Hamersley Range, 9 Aug. 1973, M.E. Trudgen 378 (BRI, PERTH); Hamersley Range N.P., 8.4 km W of Marandoo springs on ‘new’ Mt Tom Price road, 8 May 1977, M.E. Trudgen 1838 (PERTH); Hamersley Range N.P., 5.7 miles [9.2 km] from Milli-Milli springs on the track to Coppin Pools, 7 May 1980, M.E. Trudgen 2422 (BRI, PERTH); Tom Price–Karijini road, 34.5 km E of Tom Price, 24 July 2004, J.E. Wajon 1111 (PERTH).

*Distribution and habitat.* *Solanum piceum* occurs in the Pilbara and Gascoyne bioregions of Western Australia, near the towns of Tom Price, Paraburadoo and Newman (Figure 11). It grows on creek banks and creek flats, in communities dominated by *Acacia aneura* or *A. sibirica* with an understorey of spinifex or tussock grassland, on fine red to brown loam.

*Phenology.* Flowers are recorded from December to August; fruits are recorded for January, May and August.

*Conservation status.* A common species with a wide distribution, including occurrences in national parks.

*Etymology.* From the Latin *piceus* meaning ‘pitch-black’ or ‘of pitch’. This is in reference to the black mature fruits.

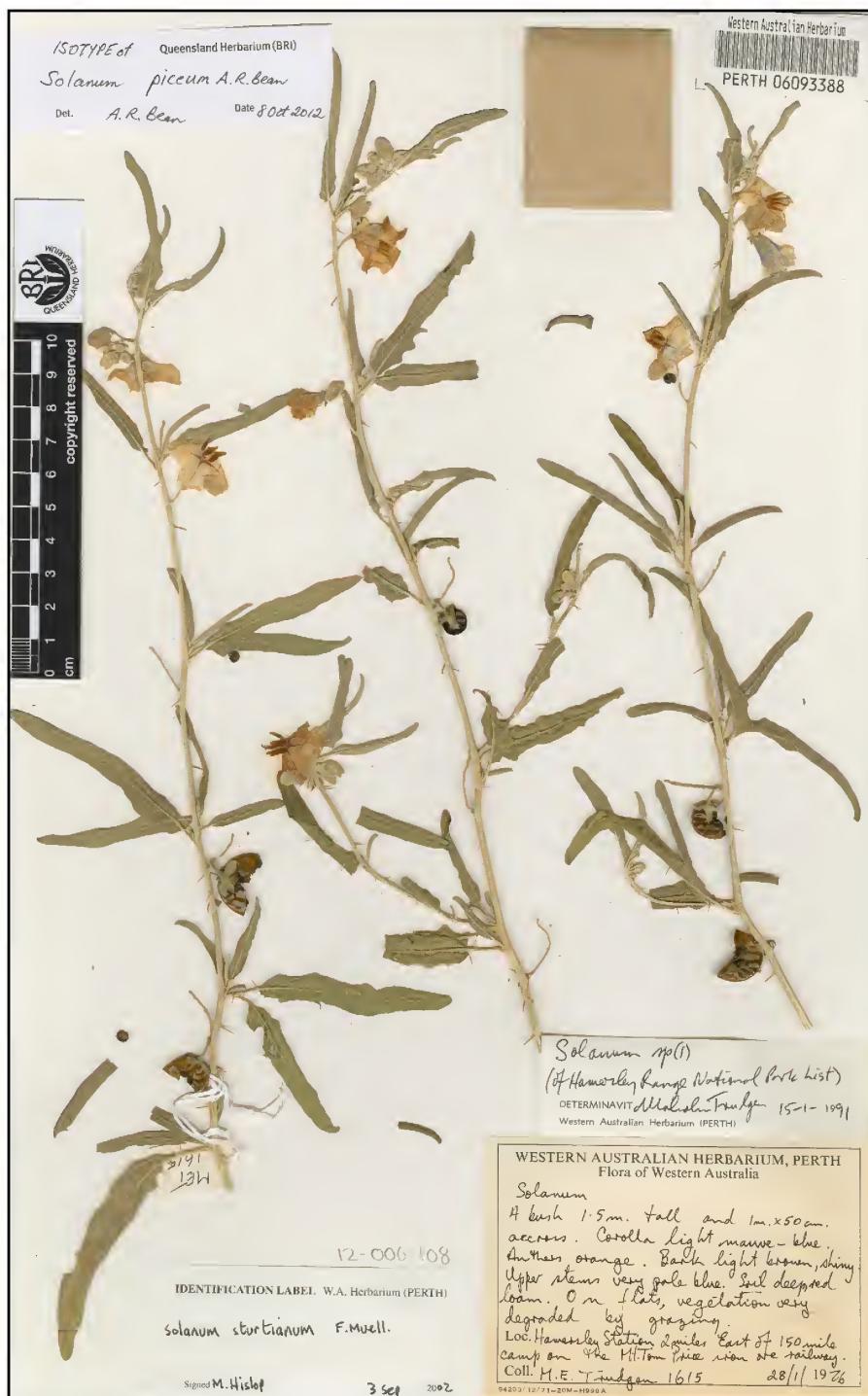


Figure 13. Isotype of *Solanum piceum* (M.E. Trudgen 1615).

*Affinities.* Related to *S. morrisonii*, but differing by the 6–25 branchlet prickles per 0.1 m of stem (0–5 for *S. morrisonii*), the presence of prickles on the leaf laminae, the larger stellate hairs on the upper and lower leaf surfaces and the calyx, and the calyx stellate hairs having a central ray 0.2–0.5 times as long as the laterals (absent for *S. morrisonii*).

**8. *Solanum sturtianum*** F.Muell., *Trans. Philos. Soc. Victoria* 1: 19 (1854). *Hooker's J. Bot. Kew Gard. Misc.* 8: 166 (1856). *Type:* 'interior of South Australia', 1844 or 1845, C.N. Sturt 87 (*lecto*: MEL 11651), *fide* A.R. Bean, *Austrobaileya* 6: 792 (2004).

*Illustrations.* G.M. Cunningham, W.E. Mulham, P.L. Milthorpe & J.H. Leigh, *Pl. Western N.S.W.* 589 (1981); R. McKenzie, *Austr. Poisonous Pl., Fungi & Cyanobacteria* 556–7 (2012).

Erect shrub 0.3–1.2 m high. Juvenile leaves entire. Adult branchlets white or grey, with a very dense indumentum; prickles absent or present, 0–10 per 0.1 m of stem, straight, broad-based, 2–8 mm long, 4–8 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs 0.3–0.5 mm diam., sessile, with 12–16 porrect lateral rays, the central ray absent. Adult leaves narrow-lanceolate or lanceolate, entire; lamina 3.7–9.8 cm long, 1.0–1.8 cm wide, 3.1–5.7 times longer than broad, apex obtuse or acute, base cuneate, cordate or obtuse; oblique part 0–5 mm long, obliqueness index 0–6%; petiole 0.6–1.3 cm long, 15–27% length of lamina, prickles absent or present. Upper leaf surface grey-green to grey, with a moderately dense to very dense indumentum; prickles absent; stellate hairs 0.1–0.2 mm apart, 0.15–0.3 mm across, sessile, with 12–15 porrect lateral rays, the central ray absent. Lower leaf surface white, grey or silvery, with a very dense indumentum; prickles absent; stellate hairs 0.03–0.07 mm apart, 0.2–0.3 mm diam., sessile, with 12–16 porrect lateral rays, the central ray absent. Inflorescence 5–10-flowered, with common peduncle 2–6 mm long, rachis prickles absent. Pedicels at anthesis 4–9 mm long, prickles absent. Calyx with a very dense indumentum; tube at anthesis 1.5–3.5 mm long; lobes 1.5–2.5 mm long; prickles absent; stellate hairs yellow or white, 0.15–0.25 mm across, sessile, with 12–15 lateral rays, the central ray absent. Corolla mauve to purple, 10–15 mm long, inner surface with a cluster of simple or branched hairs at apex of each lobe. Stamens with anthers 4.5–6.5 mm long; filaments papillose, 1.5–1.9 mm long. Ovary with short glandular hairs; functional style 7–10 mm long, with short glandular hairs. Mature fruits 1–3 per inflorescence, 9–12 mm diam. Fruiting pedicels 7–12 mm long. Seeds 3.8–5.1 mm long. (Figures 6D, 14)

*Selected specimens examined.* WESTERN AUSTRALIA: 5 km W of Gill Pinnacle turnoff on the road to Warakurna near the Schwerin Mural Crescent sign, 23 June 2007, L.S. Sweeney 7114 (PERTH). NORTHERN TERRITORY: 4 miles E of Dead Bullock Dam, Tempe Downs, 23 Nov. 1954, G. Chippendale 568 (BRI); 42 miles SW of Ooratippa HS, Central Australia, 12 July 1957, G. Chippendale 3534 (BRI); 3 miles W of Stuart Hwy, 3 miles S of Finke River crossing, 13 July 1963, A.S. George 5020 (PERTH); 23 miles [37 km] SSE of Alice Springs township, 17 Aug. 1956, M. Lazarides 5728 (BRI). SOUTH AUSTRALIA: Moonaree Station, 5 km W of Moonaree HS, 29 May 1992, F.J. Badman 5256 (BRI); between Blinman and Wirrealpa Station, 27 Oct. 1955, R. Hill 375 (BRI); Willow Springs Station, 15 July 2000, K.R. McDonald KRM 517 (BRI). QUEENSLAND: 17.9 km from 'Plevna Downs' HS, towards Eromanga, 29 Aug. 2010, A.R. Bean 30118 (BRI, CANB, NY); 32.2 km along Coonanberry Creek road, WSW of Eromanga, 31 Aug. 2010, A.R. Bean 30184 (BRI); c. 13 km due S of Thargomindah, on road to Hungerford, 27 Sep. 2002, A.B. Pollock ABP 1359 & R.J. Price (BRI); Grey Range, c. 74 km from Thargomindah on road to Noccundra, 20 July 1977, R.W. Purdie 735 (BRI). NEW SOUTH WALES: 78.1 km from 'Olive Downs' HS via Jump Up Loop Rd, on Gorge Loop Rd, ENE of Tibooburra, 6 Sep. 1989, R.G. Coveny 13583 *et al.* (BRI); 18.6 km SW of Broken Hill on the Barrier Hwy, 26 Aug. 2010, R.A. McKenzie RAM 10/112 (BRI);

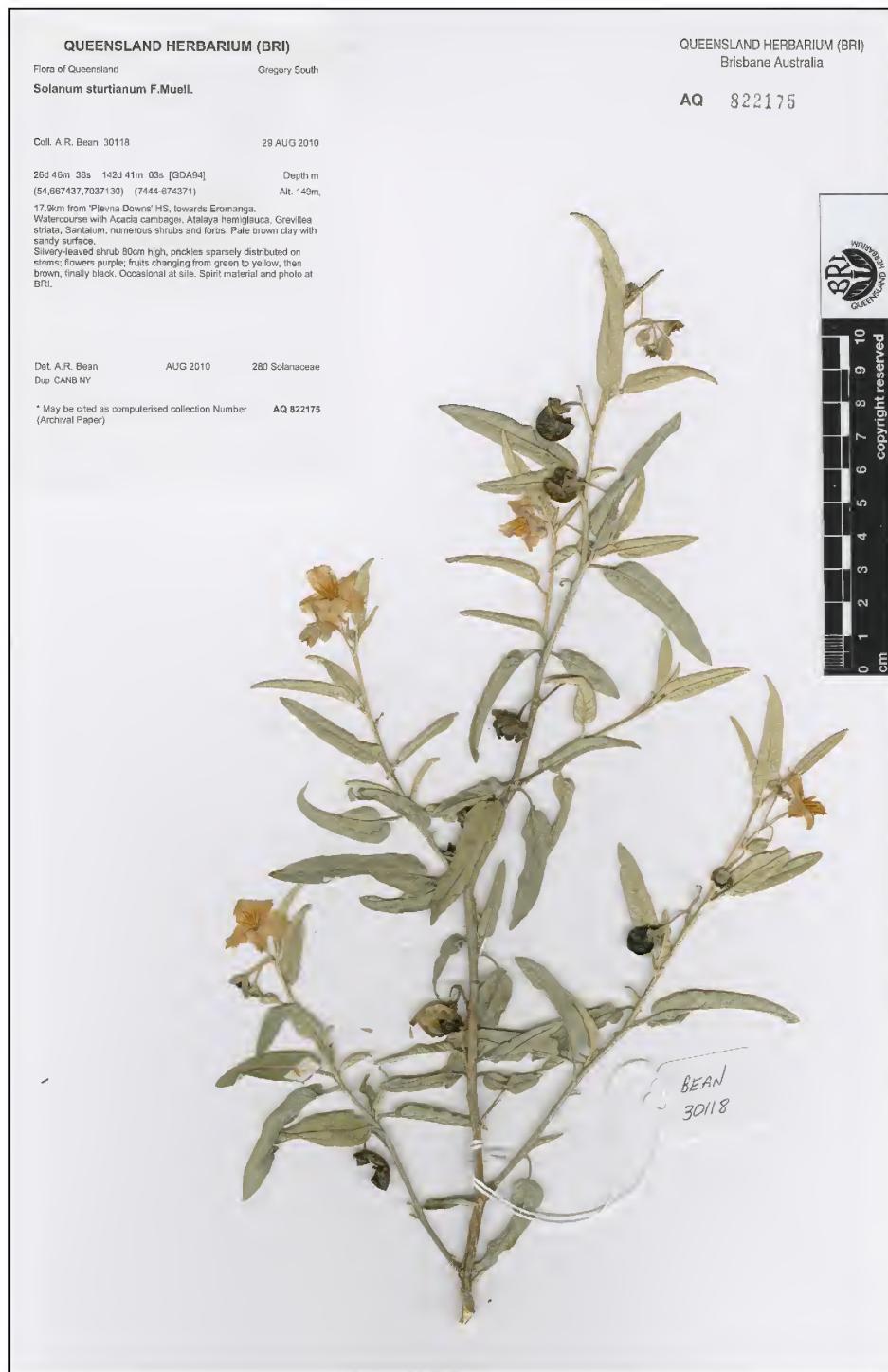


Figure 14. Representative specimen of *Solanum sturtianum* (A.R. Bean 30118).

tributary of Dense Camp Creek, Mundi Mundi Range, 14 Jan. 2000, P.G. Wilson 1481 (BRI, CANB). VICTORIA: Wangan, Walker Rd, 1 km W of intersection with Meridian Rd, 1 Dec. 2011, V. Stajsic 6000 & D.E. Albrecht (BRI).

**Distribution and habitat.** *Solanum sturtianum* occurs in the arid parts of Queensland, New South Wales, South Australia and the Northern Territory, and also extends just into Western Australia and Victoria (Figure 15). It occurs on slopes or drainage lines in undulating terrain on red, stony or gravelly loams, often in association with *Acacia aneura*, *A. cambagei* or *A. sibirica* and various shrubs, or in chenopod shrubland.

**Phenology.** Flowers and fruits have been recorded for every month except December.

**Conservation status.** A common species with a wide distribution, including occurrences in national parks.

**Etymology.** Named for Charles Napier Sturt (1795–1869), famous Australian explorer and surveyor.

**Common name.** Thargomindah nightshade.

**Affinities.** *Solanum sturtianum*, *S. morrisonii* and *S. elatius* have small foliar stellate hairs in which the central ray is lacking, and none of these species has prickles on the leaf lamina. *Solanum sturtianum* is also closely related to *S. austropiceum*, but differs from the latter by the broad-based prickles, the smaller stellate hairs without a central ray, the lack of prickles on the leaf lamina, and the ovary with small glandular hairs.

**Notes.** *Solanum sturtianum* has recently been recorded from Victoria for the first time, very close to the New South Wales border. The most westerly occurrence of *S. sturtianum* is represented by L.S.J. Sweedman 7114 (PERTH), from Gill Pinnacle in eastern Western Australia; this specimen is atypical in that at least three of the inflorescences are 2-branched.

**9. *Solanum morrisonii*** Domin, *Biblioth. Bot.* 89: 577 (1929). *Solanum tetrandrum* var. *angustifolium* A.Morrison, *J. Bot.* 50: 275 (1912). **Type citation:** ‘Ashburton River, October’. **Type:** between Globe Hill and Minderoo, Ashburton River, Western Australia, 7 October 1905, A. Morrison s.n. (*lecto*, here designated: BM 0008468332; *isolecto*: BM 000846790, E 00279463, PERTH 03699226).

Erect shrub 0.3–1.0 m high. Juvenile leaves entire. Adult branchlets white, grey or brown, with a very dense indumentum; prickles absent or present, 0–5(–22) per 0.1 m of stem, straight, broad-based, 1–6.5 mm long, 4–8 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs 0.2–0.3 mm diam., sessile, with 11–16 porrect lateral rays, the central ray absent. Adult leaves lanceolate to linear, entire; lamina 3.6–9.4 cm long, 0.4–1.1 cm wide, 6.4–14 times longer than broad, apex acute or obtuse, base cuneate; oblique part 0–5 mm long, obliqueness index 0–9%; petiole 0.4–1.5 cm long, 9–22% length of lamina, prickles absent. Upper leaf surface green, with a very sparse to moderately dense indumentum; prickles absent; stellate hairs 0.15–0.5 mm apart, 0.1–0.2 mm across, sessile, with 11–16 porrect lateral rays, the central ray absent. Lower leaf surface grey-green, with a sparse to dense indumentum; prickles absent; stellate hairs 0.15–0.3 mm apart, 0.15–0.2 mm diam., sessile, with 11–16 porrect lateral rays, the central ray absent. Inflorescence 5–10-flowered, with common peduncle 0–5 mm long, rachis prickles absent. Pedicels at anthesis 8–13 mm long, prickles absent. Calyx with a moderately dense to very dense indumentum; tube at anthesis 1.5–2.5 mm long; lobes 1–2.5 mm long; prickles absent; stellate hairs yellow or white, 0.1–0.25 mm across, sessile, with

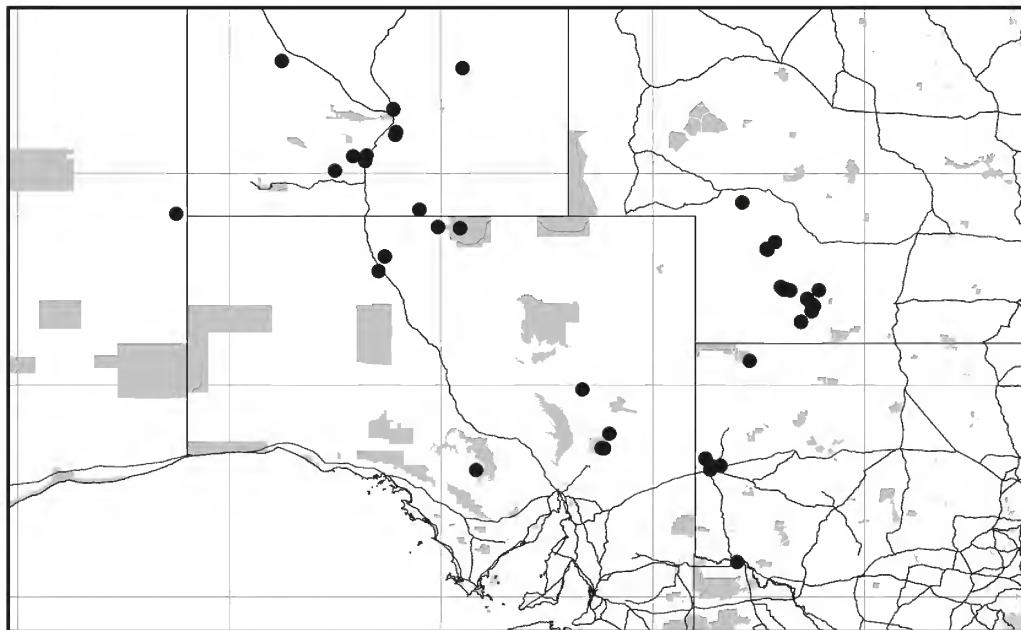


Figure 15. Distribution of *Solanum sturtianum*.

11–16 lateral rays, the central ray absent. Corolla purple, 9–18 mm long, inner surface usually with a cluster of branched or simple hairs at the apex of each lobe. Stamens with anthers 4.8–7.1 mm long; filaments lacunose or smooth, 0.7–1.7 mm long. Ovary with short glandular hairs; functional style 9–10.5 mm long, with short glandular hairs on proximal half. Mature fruits 1–5 per inflorescence, 11–15 mm diam. Fruiting pedicels 10–16 mm long. Seeds 3.8–5.7 mm long. (Figures 6E, 16)

*Selected specimens examined.* WESTERN AUSTRALIA: 68 miles S of Onslow, 28 May 1962, T.E. Aplin 1602 (PERTH); Fortescue Marsh, beside Port Hedland–Newman railroad, 10 May 2006, A.R. Bean 25435 (B, BM, BRI, MEL, NY, PERTH); Fortescue Marsh, beside Port Hedland–Newman railroad, 10 May 2006, A.R. Bean 25437 (BRI, L, NSW, PERTH); 48 miles [77 km] W of Roy Hill on Wittenoom road, 12 Aug. 1965, A.C. Beaglehole ACB 11425 (CANB, PERTH); track behind station to Yanarie River, within 200 m of homestead, Yanrey Station, 6 May 2004, G. Byrne 942 (PERTH); 53 km S of Onslow on Onslow–Carnarvon road, 28 May 1962, J.R. Cannon JRC 620515 (PERTH); Minilya River, 27 Aug. 1932, C.A. Gardner 3179 (PERTH); near Fortescue River, 14.8 km S of Hesta Siding, 10 May 2006, B.J. Lepisci 6001 & L.A. Craven (BRI, CANB; AD, DNA, K, L, MEL, MO, NSW, NY, PERTH, to be distributed); c. 100 km N of Newman and 20 km W of Great Northern Hwy, 8 May 1996, A.A. Mitchell PRP 1017 (PERTH); 28.8 km from Marillana HS on a bearing of 305 degrees, 10 May 1996, A.A. Mitchell PRP 1032 (PERTH); near Bob's Bore, 14.1 km from Yarraloola HS on a bearing of 251 degrees, 6 Nov. 1996, A.A. Mitchell PRP 1717 (PERTH); c. 8 km N of Kooline Bore, Kooline Station, c. 140 km SW of Paraburadoo, 13 May 1997, A.A. Mitchell 4729 (PERTH); c. 20 km E of Wanutarra Station HS, c. 220 km W of Paraburadoo, 15 May 1997, A.A. Mitchell 4736 (BRI, PERTH); 11 km N of Mt George, c. 36 km E of Wittenoom, 28 Mar. 1984, K. Newbey 10027 (PERTH); 18 km NE of Mt Marsh, c. 95 km E of Wittenoom, 28 June 1984, K. Newbey 10220 (PERTH); 107 km E of Wittenoom, 22 July 1976, C.I. Stacey CIS 505 (PERTH); Nanutarra Station, W.A. resource monitoring site No. 2, 7 Aug. 1986, J. Stretch s.n. (PERTH).

**Distribution and habitat.** *Solanum morrisonii* is found in the Pilbara and Carnarvon bioregions of Western Australia, south of 21.5 degrees latitude (Figure 7). It grows on floodplains, clay plains, flats or depressions. Soil is often clayey, but may also be orangy red to red-brown loam or clay loam, sometimes salt-encrusted. It may be associated with *Acacia victoriae* or other *Acacia* spp., and various grasses (including *Triodia* spp.), and succulent species of the family Chenopodiaceae, such as *Atriplex amnicola*.

**Phenology.** Flowers are recorded from March to August; fruits have been recorded from May to September.

**Conservation status.** A common species with a wide distribution, including occurrences in national parks.

**Etymology.** Named for the collector of the type, Alexander Morrison (1849–1913).

**Affinities.** *Solanum morrisonii* has a similar distribution to *S. elatius*, and the two are clearly closely related. *Solanum morrisonii* differs from *S. elatius* by its smaller stature, lack of prickles, sparse foliar indumentum (especially the upper surface), presence of small glandular hairs on the lower part of the style and on the ovary (glabrous for *S. elatius*) and entire juvenile leaves. *Solanum morrisonii* grows on floodplains, clay plains or depressions, while *S. elatius* prefers red sand plains.

## 10. *Solanum elatius* A.R.Bean, sp. nov.

Affinis *S. morrisonii* Domin sed altitudine sua majore, foliorum paginis canis vel argenteis indumento pilorum stellatorum denso usque densissimo praeditis, pagina interiore corollae glabra, ovario styloque glabro et foliis juvenilibus conspicue lobis differens.

**Typus:** Karijini National Park, 17 km along Karijini Drive from ranger station, Western Australia, 16 September 2006, D. Halford Q 9193 (*holo*: BRI AQ742632; *iso*: BM, NY, PERTH 07800940).

Erect shrub 0.6–2.5(–3.0) m high. Juvenile leaves with 1–3 conspicuous basal lobes. Adult branchlets white to silvery, with a very dense indumentum; prickles absent or present, 0–8 per 0.1 m of stem, straight or curved, broad-based, 2.5–8 mm long, 4–7 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs 0.15–0.3 mm diam., sessile, with 11–16 porrect lateral rays, the central ray absent. Adult leaves narrow lanceolate to linear, entire; lamina 4.0–9.2 cm long, 0.45–1.2 cm wide, 5.7–16 times longer than broad, apex acute or obtuse, base cuneate; oblique part 0–3 mm long, obliqueness index 0–5%; petiole 0.6–1.4 cm long, 9–20% length of lamina, prickles absent. Upper leaf surface silvery, with dense to very dense indumentum; prickles absent; stellate hairs 0.05–0.1 mm apart, 0.1–0.25 mm across, sessile, with 11–16 porrect lateral rays, the central ray absent. Lower leaf surface silvery, with dense to very dense indumentum; prickles absent; stellate hairs 0.05–0.15 mm apart, 0.1–0.25 mm diam., sessile, with 11–16 porrect lateral rays, the central ray absent. Inflorescence 6–17-flowered, with common peduncle 1–12 mm long, rachis prickles absent. Pedicels at anthesis 6–12 mm long, prickles absent. Calyx with a very dense indumentum; tube at anthesis 2–4 mm long; lobes deltate, 1–2 mm long; prickles absent; stellate hairs pale yellow or white, 0.15–0.25 mm across, sessile, with 12–16 lateral rays, the central ray absent. Corolla purple, 11–20 mm long, inner surface usually without any hairs at the apex of each lobe. Stamens with anthers 5.3–6.9 mm long; filaments lacunose or smooth, 1–1.5 mm long. Ovary glabrous; functional style 10–11 mm long, glabrous. Mature fruits 1–6 per inflorescence, 11–14 mm diam. Fruiting pedicels 9–14 mm long. Seeds 4.0–5.2 mm long. (Figures 1B, 1D, 2B, 6F, 17)



Figure 16. Representative specimen of *Solanum morrisonii* (A.R. Bean 25435).

Figure 17. Holotype of *Solanum elatius* (D. Halford Q 9193).

*Selected specimens examined.* WESTERN AUSTRALIA: Tom Price, 23 July 1978, K.J. Atkins 313 (PERTH); 54 km from Newman on road to Marble Bar, 1 May 2006, A.R. Bean 25243 (BM, BRI); old Highway 1, near ‘Ethel Creek’, NE of Newman, 5 May 2006, A.R. Bean 25314 (BRI, E, W); 8.4 km N of ‘Balfour Downs’ HS, ENE of Newman, 5 May 2006, A.R. Bean 25334 (BRI, NSW, PRE); Nullagine, 73 miles S of Marble Bar, 12 Aug. 1965, A.C. Beaglehole 11392 (PERTH); on Tom Price road, c. 10 miles S of Hamersley Gorge, 29 Sep. 1969, M.I. Brooker 2167 (PERTH); 21 miles N of Minilya River bridge on Carnarvon–Onslow road, 2 June 1966, J.R. Cannon JRC 660608 (PERTH); 51 miles S of Barradale, 29 Aug. 1973, H. Demarz 4470 (PERTH); Cane River Conservation Park, 23.6 km NNE of Mt Murray, 99.7 km SE of Onslow, 28 June 2011, S. Dillon & A. Markey CR 9005 (BRI, PERTH); 7.5 km NW of turnoff to Mount Minnie Station on Onslow road, 19 May 1999, D.J. Edinger 1712 (PERTH); 14 miles [23 km] W of Millstream Station, towards Yarraloola Station, Aug. 1967, C.H. Gittins 1468 (BRI); junction of track to Brockman mine and powerline service track, c. 40 km NNW of Tom Price, 23 Sep. 2006, D. Halford Q 9250 (AD, BRI, PERTH); West Angelas, 24 Dec. 1975, S. Janicke U 16 (PERTH); c. 20 km NW of Mt Bruce, 7 June 1994, A.A. Mitchell 3626 (PERTH); c. 20 km E of Nullagine on Skull Springs Rd, to Woodie Woodie, 31 Oct. 1995, A.A. Mitchell PRP 960 (PERTH); on the Jigalong–Lake Disappointment track, c. 20 km E of Jigalong, 26 June 1996, A.A. Mitchell PRP 1239 (PERTH); 8 km NE of Quarry Hill, c. 120 km W of Tom Price, 4 Aug. 1984, K. Newbey 10680 (PERTH); Juna Downs Station, 29 Mar. 1995, H.J. Pringle PRP 11 (PERTH); Burkett Road, 6 km W of North West Coastal Hwy, 23 July 2002, J.E. Wajon 521 (PERTH); Marindoo Camp, c. 1 mile S of Mt Bruce, Hamersley Range N.P., 7–9 Aug. 1973, A.S. Weston 8494 (PERTH).

*Distribution and habitat.* Common throughout much of the Pilbara bioregion and the northern half of the Carnarvon bioregion of Western Australia (Figure 4). It mostly occurs on red-soil sand plains dominated by spinifex (*Triodia* spp.) or rocky areas with shallow sandy to loamy soil. Frequently associated species include Mulga and various other *Acacia* spp., also *Senna* spp. and *Ptilotus nobilis*.

*Phenology.* Flowers are recorded from March to November; fruits are recorded from May to November.

*Conservation status.* A common species with a wide distribution, including occurrences in national parks.

*Etymology.* From the Latin *elatior*, meaning ‘taller’. *Solanum elatius* is considerably taller than any other arid-zone *Solanum* species in Australia.

*Affinities.* *Solanum elatius* is most closely related to *S. morrisonii*, but it differs from the latter by its usually taller stature, the grey or silvery leaf surfaces with a dense to very dense cover of stellate hairs, the inner surface of the corolla glabrous, the glabrous ovary and style, and the conspicuously lobed juvenile leaves. The two species occupy different habitats, with *S. elatius* preferring red sand plains and *S. morrisonii* growing on floodplains, clay plains or depressions.

*Notes.* The label for Mitchell PRP 1239 states that the species is ‘up to 3 m tall’, and several other labels indicate heights nearly as great e.g. 2.5 m, 8 feet.

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## A re-assessment of the varieties recognised in *Verticordia plumosa* (Myrtaceae: Chamelaucieae)

Anne M. Harris<sup>1</sup> and Barbara L. Rye<sup>2</sup>

<sup>1</sup>Swan Coastal Branch, Department of Environment and Conservation,  
PO Box 459, Wanneroo, Western Australia 6065

<sup>2</sup>Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983  
Corresponding author, email: Barbara.Rye@dec.wa.gov.au

### Abstract

Harris, A.M. & Rye, B.L. A re-assessment of the varieties recognised in *Verticordia plumosa* (Myrtaceae: Chamelaucieae). *Nuytsia* 23: 163–170 (2013). The seven varieties of *Verticordia plumosa* (Desf.) Druce are re-assessed in the light of recent collections. *Verticordia plumosa* var. *pleiobotrya* A.S.George is reduced to a synonym of *V. plumosa* var. *brachyphylla* (Diels) A.S.George. A key and distribution maps are provided for the six remaining varieties, two of which have conservation priority.

### Introduction

*Verticordia* DC. is a Western Australian genus belonging to the subtribe Chamelaciinae (DC. ex F.Rudolphi) Arn. of Myrtaceae tribe Chamelaucieae DC. Its type species is the extremely variable *V. plumosa* (Desf.) Druce. George (1991) recognised seven varieties for *V. plumosa*, but noted that most of the varieties were linked by intermediate specimens and that this taxonomically difficult complex needed further study. Four of the varieties are widespread and known from numerous populations in the south-west of Western Australia. The other three, var. *ananeotes* A.S.George, var. *pleiobotrya* A.S.George and var. *vassensis* A.S.George, are restricted to a strip along the west coast between Perth and Augusta. These three varieties have conservation priority (Smith 2012), making it particularly important that their delimitation is clear.

Recent surveys of *V. plumosa* var. *pleiobotrya* populations have revealed greater morphological variation than was previously known for the taxon and the collectors had difficulty distinguishing it from the more common and widespread var. *brachyphylla* (Diels) A.S.George. In this paper, var. *pleiobotrya* is reduced to synonymy and the other six varieties are assessed to determine how distinctive they are and to provide additional information to assist with their identification.

### Published descriptions, keys and illustrations

Brief descriptions and a key to the seven varieties of *V. plumosa* were given in George (1991: 353–354). The same key was included in George and Pieroni (2002), with some additional notes and also beautiful colour illustrations of all the varieties. In these publications, var. *ananeotes* was distinguished from

the other six varieties in being lignotuberous, while var. *vassensis* and var. *pleiobotrya* were described as having smaller flowers than the other five varieties and distinguished from one another by their sepal and petal width as well as the arrangement of their flowers. Variety *pleiobotrya* was recorded as having narrower sepals and petals than all the other varieties.

### Distributions of the varieties and intermediate specimens

In George (1991), three of the varieties of *V. plumosa*—var. *plumosa*, var. *incrassata* A.S.George and var. *vassensis*—were depicted as being geographically separated on Map 37, although var. *plumosa*, which is shown by solid, inverted triangles, was omitted from the caption. Map 44 showed var. *brachyphylla* and var. *grandiflora* (Benth.) A.S.George, again as being geographically separated, while the remaining two varieties were shown on Map 43 (var. *pleiobotrya*) and Map 39 (var. *aneotes*) respectively. Intermediates were noted between:

1. var. *brachyphylla* and var. *incrassata* (some var. *incrassata* specimens from Fitzgerald River National Park having a tendency towards var. *brachyphylla*);
2. var. *brachyphylla* and var. *vassensis* (e.g. Darkin Reserve and Bowelling);
3. var. *grandiflora* and var. *incrassata* (intergrading from Scadden southwards);
4. var. *grandiflora* and var. *plumosa* (Cape Riche);
5. var. *plumosa* and var. *vassensis* (e.g. near Manjimup and Scott River).

Maps in George and Pieroni (2002) showed a greater overlap in the ranges of the varieties, partly as a result of the greater number of specimens available by that time, and by 2012 the distribution maps of the varieties in *FloraBase* (Western Australian Herbarium 1998–) showed even greater overlaps. In addition to the intermediates listed above, some of the current specimens have been identified as being intermediates between:

1. var. *aneotes* and var. *vassensis* (Ruabon), with some specimens labelled as being hybrids, i.e. *Verticordia plumosa* var. *aneotes* × *vassensis*, a name which also appears on *FloraBase*;
2. var. *brachyphylla* and var. *grandiflora* (Fitzgerald River National Park);
3. var. *brachyphylla* and var. *plumosa* (Mt Frankland area).

Of particular concern in the above list is the large number of intermediates recorded involving the rare *V. plumosa* var. *vassensis*, with some of the intermediates occurring far outside the recorded range of the variety.

### Recent collections and germination studies

Cochrane *et al.* (2001) measured seed production and germination rates in the three rare varieties of *V. plumosa*. They found the lowest proportion of seed set (5.4%) in the lignotuberous (resprouter) var. *aneotes*, and also the lowest germination rate (26%) based on a sample of 63 seeds obtained from a single large population visited five times between March 1994 and February 1999. Only one visit, in February 1995, was made to a much larger population of the non-lignotuberous var. *pleiobotrya*, which had a much higher seed set (24%) and a higher germination rate (72%) from a similar-sized sample of seeds. Five populations of the other non-lignotuberous variety, var. *vassensis*, were visited

between February 1997 and February 1999; this taxon had a low seed set (7.7%) and an intermediate germination rate (46%) was obtained from 176 seeds. Hence, var. *vassensis* may be the most at risk of the three varieties since it is unable to regenerate from a lignotuber and also appears to have a low seed set.

Andrew Crawford collected fruiting samples from two known populations of var. *pleiobotrya* in December 2007. One of us, Anne Harris, collected specimens from two other known populations in December 2011. However, some of these specimens were later identified as var. *brachyphylla*, and when the specimens from the Swan Coastal Plain housed under these two varietal names were compared in February 2012 there appeared to be no consistency in the determinations. Alex George (pers. comm.) identified all the December 2011 collections as being of var. *pleiobotrya*, which he still considered to be sufficiently distinct to maintain as a separate variety although he agreed that the recent specimens had increased the morphological variation known within it.

As can be seen from Table 1, the greater range of variation now known for the characters previously considered to separate var. *pleiobotrya* from var. *brachyphylla* means that there is a considerable overlap in each of them. Even when measurements were taken only from the few specimens known by 1991, these characters were found to be more variable than recorded in George (1991), with some overlap in each character. As there are now no reliable characters available to distinguish the two varieties, the decision has been made to reduce var. *pleiobotrya* to a synonym of var. *brachyphylla*.

Among the large number of recent collections from populations of *V. plumosa* within the mapped range of var. *vassensis*, there is a similar confusion of identifications, in this case involving three other varieties, var. *ananeotes*, var. *brachyphylla* and var. *plumosa*. Outside this area, in the Darling Range, several specimens previously identified as being intermediate between var. *brachyphylla* and var. *vassensis* have been re-identified in the current study as var. *brachyphylla*. The greater variation

**Table 1.** Comparison of the morphological characters as recorded in George (1991) for two varieties of *Verticordia plumosa* with the current range of measurements recorded from the more numerous specimens now available on the Swan Coastal Plain. Note that the methods used to obtain the measurements in 2012 were different from those used in 1991 in that only the longest, fully mature peduncles were measured on each specimen and only the longest, i.e. outermost, sepals were measured.

<i>V. plumosa</i> var. <i>pleiobotrya</i>		<i>V. plumosa</i> var. <i>brachyphylla</i>	
	1991	2012	1991
<b>Peduncles</b>			
length	1.5–3(–8) mm	2–8 mm	7–11 mm
<b>Sepals</b>			
length	2.3–2.5 mm	2.3–3.3 mm	2.5–3.5 mm
lobes	narrow	narrow to broad	narrow to broad
<b>Petals</b>			
length	2–2.4 mm	2–3 mm	2.2–3 mm
width	1.1–1.5 mm	1.3–2.2 mm	not given
			2.2–3.2 mm
			1.5–2.2 mm

in flower size now accepted in var. *brachyphylla* as a result of including var. *pleiobotrya* within it has meant that the specimens labelled as intermediate with var. *vassensis* are now a good match for var. *brachyphylla s. lat.*

## Methods

Type material was examined at NSW and PERTH. All PERTH specimens were examined and redeterminations made for a number of specimens; this led to reductions in the number of intermediates recognised, the number of disjunct records for some of the varieties and the number of specimens that had not been identified down to the varietal level. Measurements were then taken of all the varieties from the dried material. Variation in the measurements was kept to a minimum by scoring the largest leaves on each specimen and taking care to measure the inflorescence and floral organs when they were fully mature. Distributions were plotted, using DIVA-GIS Version 5.2.0.2, from data obtained from *FloraBase* (Western Australian Herbarium 1998–), on maps showing the version 6.1 Interim Biogeographic Regionalisation for Australia (IBRA) regions (Department of the Environment, Water, Heritage and the Arts 2008).

### Key to the varieties of *Verticordia plumosa*

This new key should help with the identification of the remaining six varieties of *V. plumosa* but will not be completely reliable owing to the difficulty of this complex.

1. Shrub with a small lignotuber and several to many simple or sparsely branched stems, up to 0.4 m high. Longest leaves with a blade 7–15(–20) mm long (Serpentine–Busselton)..... var. **ananeotes**
- 1: Shrub without a lignotuber, often bushy, up to 1.5 m high.  
Longest leaves with a blade 2–10(–14) mm long

  2. Sepals 4–5.5 mm long. Petals 3.5–4.5 mm long, usually white, rarely pale pink (S of Stirling Ra.–Cape Arid NP) ..... var. **grandiflora**
  - 2: Sepals 1.8–4 mm long. Petals 2–3.8 mm long, pale to deep pink, rarely white

    3. Leaf blades 2–5 mm long, 0.6–1 mm thick. Sepals 3–4 mm long (Marvel Loch–Fitzgerald River NP–Scadden) ..... var. **incrassata**
    - 3: Leaf blades 2–10(–14) mm long, 0.35–0.6 mm thick.  
Sepals 1.8–3.5(–4) mm long

      4. Peduncles 1.5–4 mm long. Sepals 1.8–2.8 mm long. Flowering branchlets corymbose. Occurring in winter-wet sites including depressions (Busselton area) ..... var. **vassensis**
      - 4: Peduncles (2–)4–12 mm long. Sepals 2.3–4 mm long.  
Flowering branchlets with numerous groups of flowers on short lateral branchlets, or if corymbose then occurring on granite

        5. Leaf blades 7–10(–14) mm long. Sepals 2.5–4 mm long.  
Occurring on granite (Wooroloo–far south-west–Cape Riche) ..... var. **plumosa**
        - 5: Leaf blades 2–8 mm long. Sepals 2.2–3.5 mm long. Occurring mainly in low-lying sites, often in winter-wet depressions (Arrowsmith River–Scott River–Fitzgerald River NP) ..... var. **brachyphylla**

### Status of the four common varieties of *Verticordia plumosa*

*Verticordia plumosa* has four common varieties—var. *brachyphylla*, var. *grandiflora*, var. *incrassata* and var. *plumosa*—with fairly large distributions in the south-west (Figures 1, 2). Although all four show considerable morphological variation across their ranges, they can usually be distinguished fairly readily from one another on morphological grounds as well as differing in their areas of occurrence and habitat preferences. The enlarged circumscription of var. *brachyphylla*, as made formal below, has resulted in a greater range of flower size and peduncle length being accepted in this variety. The effect of adding the relatively small-flowered coastal specimens to var. *brachyphylla* has increased the average difference in flower size between var. *brachyphylla* and the other three varieties, as var. *brachyphylla* already tended to have smaller flowers.

***Verticordia plumosa* var. *brachyphylla*** (Diels) A.S.George, *Nuytsia* 7: 356 (1991). *Verticordia fontanesii* var. *brachyphylla* Diels, *Bot. Jahrb.* 35: 403 (1904). *Verticordia plumosa* var. *brevifolia* (F.Muell.) Domin, *Mém. Soc. Sci. Bohême* 1921–1922, 2: 79 (1923), *nom. illeg.* Type: near Waeel, Western Australia, October 1901, E. Pritzel s.n. (*lecto*: K n.v., *fide* A.S. George, *Nuytsia* 7: 356 (1991); *isolecto*: BM n.v., E n.v., NSW 542650, PERTH 01623044).

*Verticordia plumosa* var. *pleiobotrya* A.S.George, *Nuytsia* 7: 354–355 (1991). Type: Kargotich Road, 0.8 km south of Mundijong Road, west of Mundijong, Western Australia, 7 November 1986, A.S. George 16902 & E.A. George (*holo*: PERTH 01886851; *iso*: AD n.v., CANB n.v., MEL n.v., NSW 542676, PERTH 01883577).

*Selected specimens examined.* WESTERN AUSTRALIA: Abernethy Rd, 1.4 km E of Kargotich Rd, W of Byford (Population 6), 20 Dec. 2007, A. Crawford ADC 1732 (PERTH); Bullsbrook Nature Reserve, 5 Nov. 2003, R.M. Evans 45 (PERTH); Mundijong Rd, 200 m W of Pure Steel Lane, 14 Dec. 2011, A.M. Harris AH 203 (PERTH); Boundary Rd, Kenwick, W side of road, 1998, F. Obbens FO 524/98 (PERTH); Canning River East Branch, c. 14 km direct line ESE of the Canning Dam, 7 Nov. 2009, K.R. Thiele 3911 (PERTH).

*Distribution and habitat.* Extends from Arrowsmith River south to Scott River and south-east to Fitzgerald River National Park (Figure 1A). Occurs mainly in low-lying sites, often in winter-wet depressions.

*Flowering period.* October to December.

*Conservation status.* This variety has numerous populations in a range that extends for more than 600 km.

*Notes.* A small selection of the recently collected specimens from the Swan Coastal Plain and Darling Range is cited above. George (1991) noted that plants on the coastal plain, which now include those previously placed in var. *pleiobotrya*, tend to have longer, more slender leaves and peduncles than those from northern and inland localities. This still holds true for the leaves but not for the peduncles. Variety *brachyphylla* is the most widely distributed of the varieties and overlaps or abuts the ranges of the others.

Although *V. plumosa* var. *pleiobotrya* is no longer formally recognised, it would be worth preserving the full range of morphological variation found in the *V. plumosa* complex on the Swan Coastal Plain, both in natural populations and in cultivation.

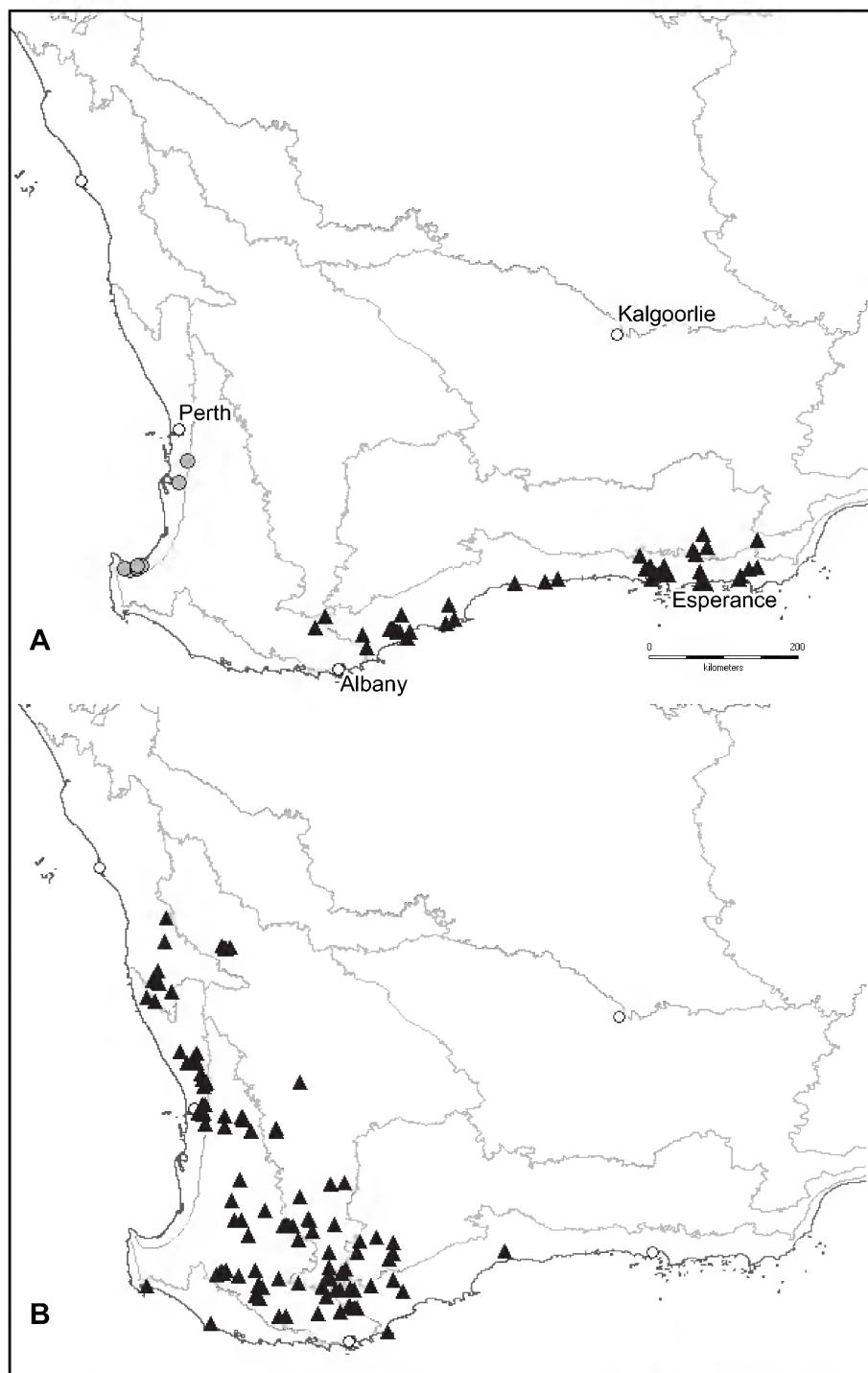


Figure 1. Distribution maps for varieties of *Verticordia plumosa*. A – var. *ananeotes* (●) and var. *grandiflora* (▲); B – var. *brachyphylla* (▲).

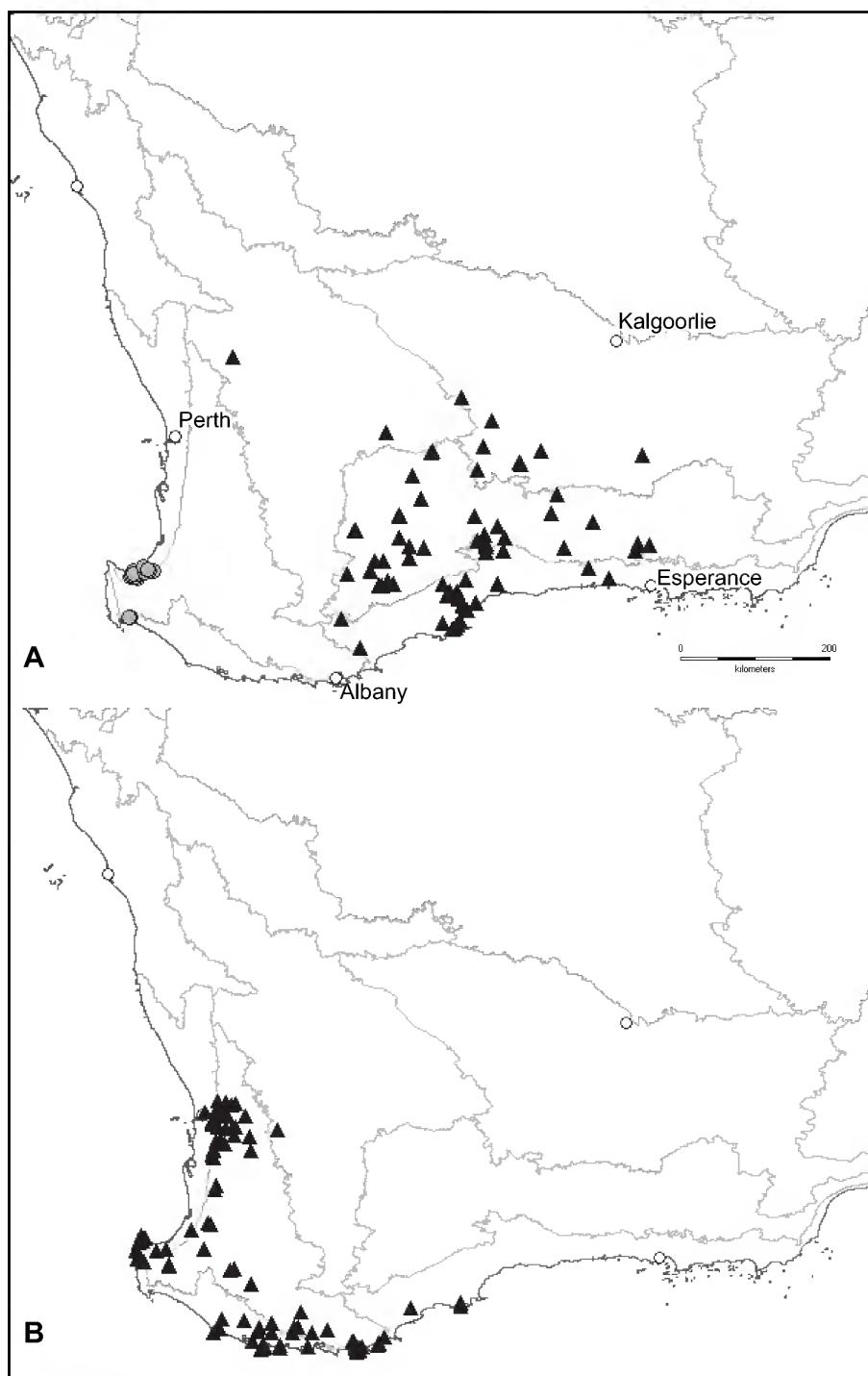


Figure 2. Distribution maps for varieties of *Verticordia plumosa*. A – var. *incrassata* ( $\blacktriangle$ ) and var. *vassensis* ( $\circ$ ); B – var. *plumosa* ( $\blacktriangle$ ).

### **Status of *Verticordia plumosa* varieties *ananeotes* and *vassensis***

Both of the uncommon varieties of *V. plumosa*—var. *ananeotes* and var. *vassensis*—are apparently being maintained in cultivation to some degree, as they were included in the plant list for the Friends of Kings Park plant sale held on 3 November 2012.

*Verticordia plumosa* var. *ananeotes* is listed as Threatened under DEC Conservation Codes for Western Australian Flora (Smith 2012); it has a restricted range (Figure 1A) and there are fewer collections of it than of any of the other varieties. It is apparently unique in having a lignotuber, and its leaves tend to be longer than in all the other varieties. Although var. *ananeotes* appears to be distinctive, it needs further study in the Ruabon area, where it apparently comes into contact with at least one of the non-lignotuberous varieties, to determine whether it interbreeds and intergrades with non-lignotuberous variants or maintains its distinctiveness.

*Verticordia plumosa* var. *vassensis* is also listed as Threatened under DEC Conservation Codes for Western Australian Flora (Smith 2012) and appears to have the smallest range of any of the varieties (Figure 2B). It was considered to have the smallest flowers, with sepals only 1.5–2.3 mm long; however, all specimens currently housed under this variety have sepals 1.8–2.8 mm long. Separation of var. *vassensis* from var. *brachyphylla* is in question now that var. *brachyphylla* includes specimens with sepals down to 2.2 mm long. However, there does appear to be a more significant difference between the two varieties in their inflorescence type, and on that basis var. *vassensis* is considered worth maintaining as a distinct variety, for now.

The whole *V. plumosa* complex certainly needs further investigation, especially in the far southwest where var. *vassensis* and three other varieties apparently overlap in range.

### **Acknowledgements**

We would like to thank Alex George for his advice, including confirmation that the specimens collected in the current study matched his concept of *V. plumosa* var. *pleiobotrya*, Mike Hislop for his advice, and the staff at NSW for access to their type material.

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**SHORT COMMUNICATION****Removal of *Gunniopsis* sp. Fortescue (M.E. Trudgen 11019) from Western Australia's plant census**

The name *Gunniopsis* sp. Fortescue (M.E. Trudgen 11019) (Aizoaceae) was added to Western Australia's vascular plant census in 1994; however, the representative voucher specimen was retained by Malcolm Trudgen 'pending publication of a flora list for the Hamersley Range, Karijini National Park'. This putative new taxon from the Pilbara bioregion is represented by a blank 'dummy sheet' at the Western Australian Herbarium (PERTH 03456927) which provides no descriptive or habitat information, and no specific locality details or collection date. *Gunniopsis* sp. Fortescue was added to the *Declared Rare and Priority Flora list for Western Australia* (Atkins 1995) following advice that it was only known from the South Fortescue Borefield Pipeline, and continues to be flagged as having Priority One conservation status (Smith 2012).

Examination of unpublished reports has revealed more precise locality information for *G.* sp. Fortescue. The voucher population (*M.E. Trudgen* 11019) was recorded by Trudgen (1992) as occurring on the Central Pilbara Rail trace, 5.7 km east of the South Fortescue Borefield Pipeline (AMG coordinates: 50K 596264E, 7503676N), with more than 1,000 plants noted. A second population of more than 1,000 plants (*M.E. Trudgen* 11375) is also noted from the rail trace at 3.5 km east of the South Fortescue Borefield Pipeline. These sites are recorded as Snake-wood (*Acacia xiphophylla*) tall shrubland over hummock grass (*Triodia longiceps*) on a gently sloping site (Trudgen 1992; Hamersley Iron 1998; Trudgen & Casson 1998).

A low resolution photograph of a pressed specimen of *G.* sp. Fortescue is reproduced in a regional rare flora identification guide (Hamersley Iron 1998); however, searches over the past 14 months have failed to locate either the voucher specimen for the phrase name or *M.E. Trudgen* 11375 (M. Trudgen pers. comm.). Moreover, *G.* sp. Fortescue has not been relocated in the field despite repeated searches at the aforementioned localities under different seasonal conditions over a period of 15 years (S. van Leeuwen pers. comm.), nor was it found by Malcolm Trudgen during surveys for the West Angelas rail line (an adjacent corridor traversing identical habitat) or for the clearing associated with the nearby Marandoo Accommodation Village and Hamersley Agriculture Project's central pivot irrigation cells (S. van Leeuwen pers. comm.). In the absence of material of this taxon, it is impossible to validate its taxonomic status or ascertain its conservation status.

Phrase names are an important way of recognising undescribed taxa in specimen and census databases until such time as they can be formally named. An important standard protocol for these names is to link them to a validating voucher specimen lodged at a recognised institution (Paczkowska & Chapman 2000; Barker 2005). In the absence of any available specimens, it is recommended that *G.* sp. Fortescue (M.E. Trudgen 11019) be removed from Western Australia's vascular plant census and accordingly from the *Threatened and Priority Flora list for Western Australia*.

No specimens from the Pilbara were known when *Gunniopsis* Pax was last revised (Chinnock 1983), and it is of note that there is only one specimen from the Pilbara bioregion in the collections at the

Western Australian Herbarium—a specimen of the Priority Three species *G. propinqua* Chinnock from east-north-east of Paraburadoo (*M. Maier & K. McCreery* BES MM 1105; PERTH 08311366). Survey botanists and industry representatives should remain alert to the need for high quality collections of *Gunniopsis* and to the possibility of undescribed species in the Pilbara bioregion.

### Acknowledgements

With thanks to Stephen van Leeuwen and Kevin Thiele for comments and discussion, and Malcolm Trudgen for his repeated efforts to locate the voucher specimen.

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### Juliet A. Wege

Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

## Two new species of *Lepidosperma* (Cyperaceae) occurring in the Perth area of Western Australia

Russell L. Barrett<sup>1</sup> and Karen L. Wilson<sup>2</sup>

<sup>1</sup>Botanic Gardens and Parks Authority, Kings Park and Botanic Garden,  
West Perth, Western Australia 6005

School of Plant Biology, Faculty of Natural and Agricultural Sciences, The University of Western Australia,  
Crawley, Western Australia 6009

Western Australian Herbarium, Department of Environment and Conservation,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983  
Corresponding author, email: russell.barrett@bgpa.wa.gov.au

<sup>2</sup>National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust,  
Mrs Macquaries Road, Sydney, New South Wales 2000  
Email: karen.wilson@rbgsyd.nsw.gov.au

### Abstract

Barrett, R.L. & Wilson, K.L. Two new species of *Lepidosperma* (Cyperaceae) occurring in the Perth area of Western Australia. *Nuytsia* 23: 173–187 (2013). *Lepidosperma apricola* R.L.Barrett is a new species from the Darling Range in Western Australia. An isolated population also occurs in Kings Park, in the heart of Perth. This species has been confused with *L. leptostachyum* Nees. in the past. *Lepidosperma calcicola* R.L.Barrett & K.L.Wilson is a new species from coastal dune systems on the west coast of Western Australia, which has been previously confused with a number of other taxa. It has been listed on *FloraBase* as *Lepidosperma* sp. Coastal Dunes (R.J. Cranfield 9963). Both are common species occurring in the Perth region of Western Australia (and more broadly in the South West Botanical Province) that have been unnamed up until now.

### Introduction

This paper is part of the on-going revision of *Lepidosperma* Labill., where Barrett and Wilson (2012) have now resolved the application of all 73 published names, paving the way for the description of currently unnamed and new taxa. A revised edition of the book *Perth plants* (Barrett & Pin Tay 2005) is in preparation and taxonomic resolution of these and a number of unnamed taxa in other groups is considered desirable prior to its publication (see also Barrett 2012c). Provision of a key to species must await the description of the majority of new species. Numerous illustrations are provided as an aid to accurate identification of the species named here.

One taxon that is common on the Darling Range near Perth is named here as *L. apricola* R.L.Barrett. This taxon has usually been included under *L. leptostachyum* Nees (Wheeler & Graham 2002 in part; Barrett & Pin Tay 2005). This species was included in the *Flora of the Perth region* as *L. sp. F* (Rye 1987). Markey (1997) also recognised this taxon as being distinct (as *Lepidosperma* Type C). This species has informally been known as *L. sp. 'leptostachyum Compact Inflorescence'* (Barrett 2006) or

*L.* sp. ‘Darling Range Heath’ (Barrett 2012b). Phylogenetic studies using molecular characters have confirmed that the taxon described here is distinct from *L. leptostachyum*, actually being more closely related to the morphologically dissimilar *L. effusum* Benth. (Barrett 2012b).

One coastal taxon that has been the subject of much confusion in the past is named here as *L. calcicola* R.L.Barrett & K.L.Wilson. Currently listed on FloraBase as *Lepidosperma* sp. Coastal Dunes (R.J. Cranfield 9963) (Western Australian Herbarium 1998–), this taxon has variously been included under *L. angustatum* R.Br. (Barrett & Pin Tay 2005), *L. costale* Nees (Barrett & Pin Tay 2005), *L. pubisquamatum* Steud. (Wheeler & Graham 2002 in part; Barrett & Pin Tay 2005), *L. squamatum* Labill. (Scott & Negus 2002), or *L.* sp. Coastal Dunes (Dixon 2011). This species was included in the *Flora of the Perth region* and the two forms included here were recognised separately as *L.* sp. B and *L.* sp. D (Rye 1987). The name *L.* sp. F1 Coastal Dunes was applied by KLW during preliminary sorting of specimens at PERTH and NSW. Application of the name *L. squamatum*, also much confused in the past, has now been resolved and is applicable to a taxon from the southern coast of Western Australia (Barrett 2012a). Molecular phylogenetic studies have confirmed that the taxon described here is distinct from each of these taxa, actually being more closely related to the morphologically dissimilar *L. scabrum* Nees (Barrett 2012b).

## Methods

The description is based on herbarium specimens only. Specimens were examined using light microscopy, and measurements of specimens followed the methods described in Barrett (2007). Leaf, culm, nut and spikelet characters were also imaged using a Jeol JCM 5000 NeoScope bench-top scanning electron microscope (SEM) at Kings Park and Botanic Garden. The senior author has also made extensive field observations of these species that have been incorporated in this manuscript.

One unusual term is used here: the ‘angle of fan (ramet) spread’. The angle of the spread of the outermost leaves of an individual ramet (a single unit in a clonal plant) or fan of growth is given as it indicates the growth habit of the plant. This can be quite useful to distinguish some taxa with distichous leaves.

The term ‘vertical rhizomes’ describe a particular mode of ramet growth in which new ramets (plantlets) are produced almost vertically above the preceding ramet, often well above the current ground level, though produced from the rhizome, not the leaves. This is a strategy adopted by a number of coastal taxa growing in areas prone to sand movement to ensure they do not get buried. Most species in the genus produce new ramets beside the existing ramet at about the same height, just below ground level. Species with vertical rhizomes can also produce new ramets at the same height by means of stoloniferous lateral rhizomes, but these are then separated from the parent ramet by this means.

Measurements of the width (diameter) of the rhizome scales, spikelets and individual bracts have been made as they are, i.e. they are not flattened, as they usually break in the process. The measurements made in the ‘curved’ position are considered to be the most accurate and repeatable means of measuring these characters.

## Taxonomy

### ***Lepidosperma apricola* R.L.Barrett, sp. nov.**

*Type:* road verge at 38 Nelson Crescent, Lesmurdie, Darling Range, east of Perth, Western Australia, 8 January 2013, R.L. Barrett RLB 7825 (*holo*: PERTH 07984588; *iso*: AD, BM, BRI, CANB, K, MEL, NE, NSW).

*Lepidosperma* sp. F, B.L. Rye, in N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane (eds), *Flora of the Perth region* 891–892 (1987).

*Clump-forming tufted perennial*, with short adventitious rhizomes which are 10–50 mm long, not vertical, forming clones to about 0.4 m across. Rhizome scales dark chocolate-brown, grading to reddish brown at the surface, becoming fibrous with age, 6.5–10.5 mm long, 2.0–4.6 mm diam., closely appressed to the rhizome, usually breaking up and becoming fibrous, the apex subacute to acute. *Culms* and *leaves* distichous; leaf to culm length ratio 0.01–0.5:1; angle of fan (ramet) spread 5–10°. *Leaves* equitant, rigid, erect, blade reduced to a short bract-like point or well developed, compressed biconvex to subterete, lacking acute margins, dull green, not glaucous, blades finely ridged or striate with 32–36 stomatal columns, 20–390 mm tall, 0.7–0.9 mm wide, 0.3–0.6 mm thick; sheath reddish brown to dark brown, glabrous, the base becoming somewhat fibrous with age, without resin. *Culms* not as compressed as leaves, usually subterete to terete, finely ridged or striate with 38–58 stomatal columns, 250–950 mm tall, 1.0–2.1 mm wide, 0.8–1.9 mm thick, lacking acute margins. *Inflorescence* compact, more or less obconic in outline, 30–75 mm long, 15–50 mm wide, with numerous short branches, one lateral branch per node; basal lateral branch 11–37 mm long with 7–22 spikelets; involucral bract 15–69 mm long. *Spikelets* 4.5–7.6 mm long, the upper flower bisexual, the lower flower functionally male. *Glumes* 6–8, keeled, dark brown, grading to reddish brown towards the margins with narrow, opaque, fimbriate margins, the exposed surface around the keel evenly covered with short, appressed to ascending white or rusty hairs (glabrous below), the apex acute to apiculate; sterile glumes 4–6; fertile glumes 4.2–7.1 mm long, 1.8–2.8 mm wide. *Hypogynous scales* 6, falling with the nut, very narrowly triangular, white, 0.9–1.4 mm long; apex acute to attenuate, with scattered short hairs. *Stamens* 3; anthers 1.8–2.4 mm long, 0.6–0.7 mm wide with an apical appendage 0.7–0.9 mm long; filaments 3.3–4.0 mm long; pollen 25–30 µm across, sub-globular, with several large irregular surface pits. *Style* 3-fid, unbranched portion 3.6–4.5 mm long, branches 1.8–2.9 mm long; style base continuous with ovary, caducous; stylar cap small. *Nut* pale brown to reddish brown, smooth, with 3 distinct ribs, obovoid, terete in section, 2.6–3.1 mm long, 1.3–1.6 mm wide; epidermal cells mostly round, some shortly oblong. (Figures 1–4)

*Diagnostic characters.* *Lepidosperma apricola* is distinctive in having the following combination of characters: compact, many-branched inflorescences with spikelets that markedly diverge from the axis of the inflorescence branchlets; terete to subterete, finely striate culms; compressed, well-developed leaf blades with bases that break down with age, becoming fibrous.

*Selected specimens examined* (52 seen). WESTERN AUSTRALIA: W of Badgingarra on Jurien Bay–Eneabba road, 27 May 1971, A.M. Ashby 3770 (PERTH); Narrogin, 30 Aug. 1959, S.T. Blake 20750 (BRI, PERTH); 30 m SE of Davey Road, 1.78 km S of junction with Redmond Hay River Road, Walpole Region, 12 Mar. 1997, N. Casson & K. Kershaw W 181.6 (PERTH); road to Mount Adams, 15.3 km from Brand Highway, 28 May 1997, R. Davis 3280 (PERTH); corner Gavins Road and Capel–Donnybrook Road, close to Donnybrook, 23 Oct. 1997, R. Davis 4427 (PERTH); Mount



Figure 1. A–H. *Lepidosperma apricola* type location and collection. A – habit; B – fibrous base of leaf sheaths; C – rhizome; D – culm; E – leaf; F – leaf sheath apex; G – spikelets; H – fruiting inflorescence (R.L. Barrett RLB 7825, PERTH). I – Flowering inflorescence of *L. leptostachyum* near York, Western Australia (not vouchered).

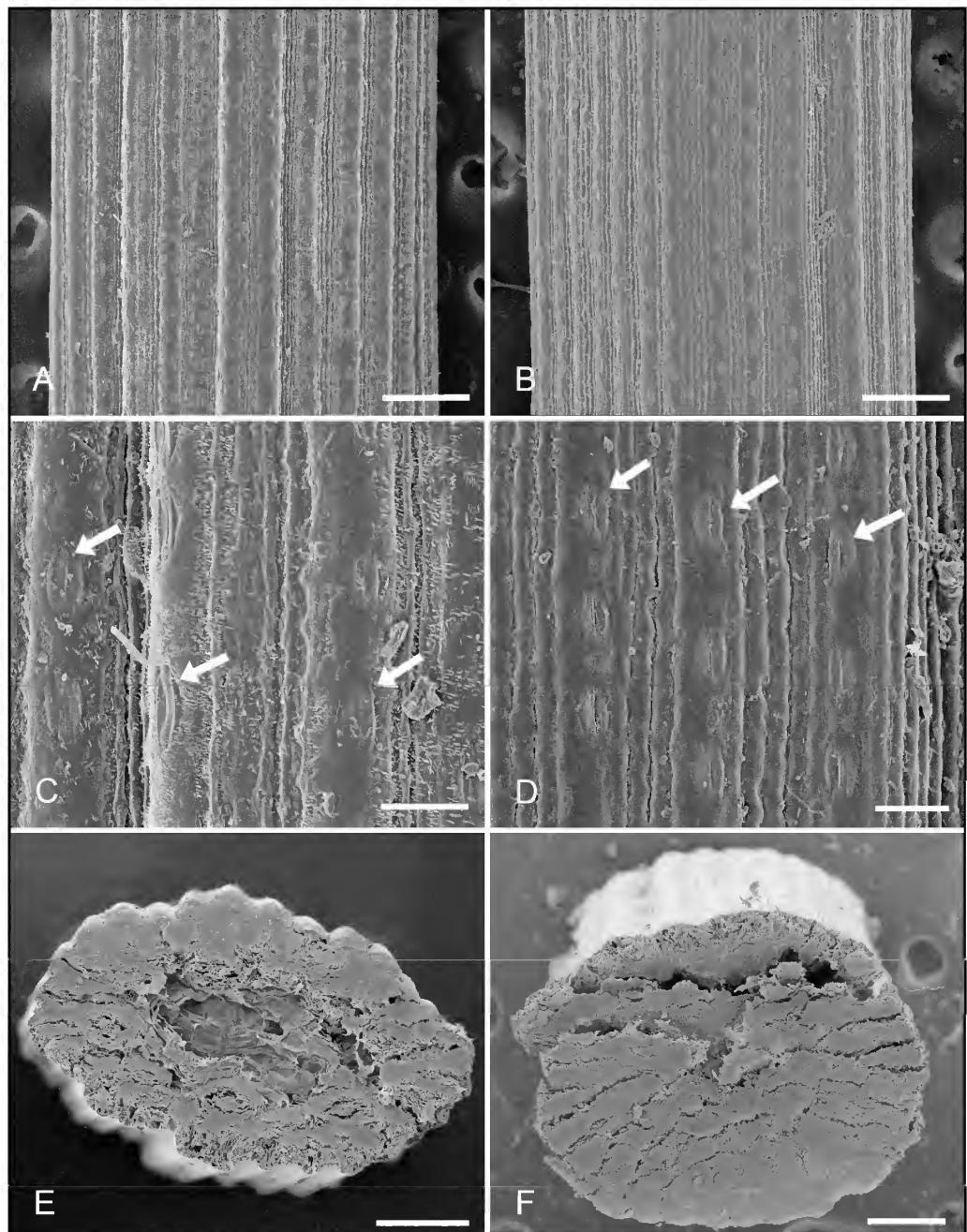


Figure 2. Leaf of *Lepidosperma apricola* (scanning electron micrographs). A – leaf surface; B – culm surface; C – stomatal columns on leaf (arrows indicate stomata); D – stomatal rows on culm (arrows indicate stomata); E – leaf cross section; F – cross section of culm (A, C, E – G.J. Keighery & N. Gibson 6286, PERTH; B, D, F – R. Davis 3280, PERTH). Scale bars. A = 200 µm; B = 200 µm; C = 50 µm; D = 100 µm; E = 200 µm; F = 200 µm.

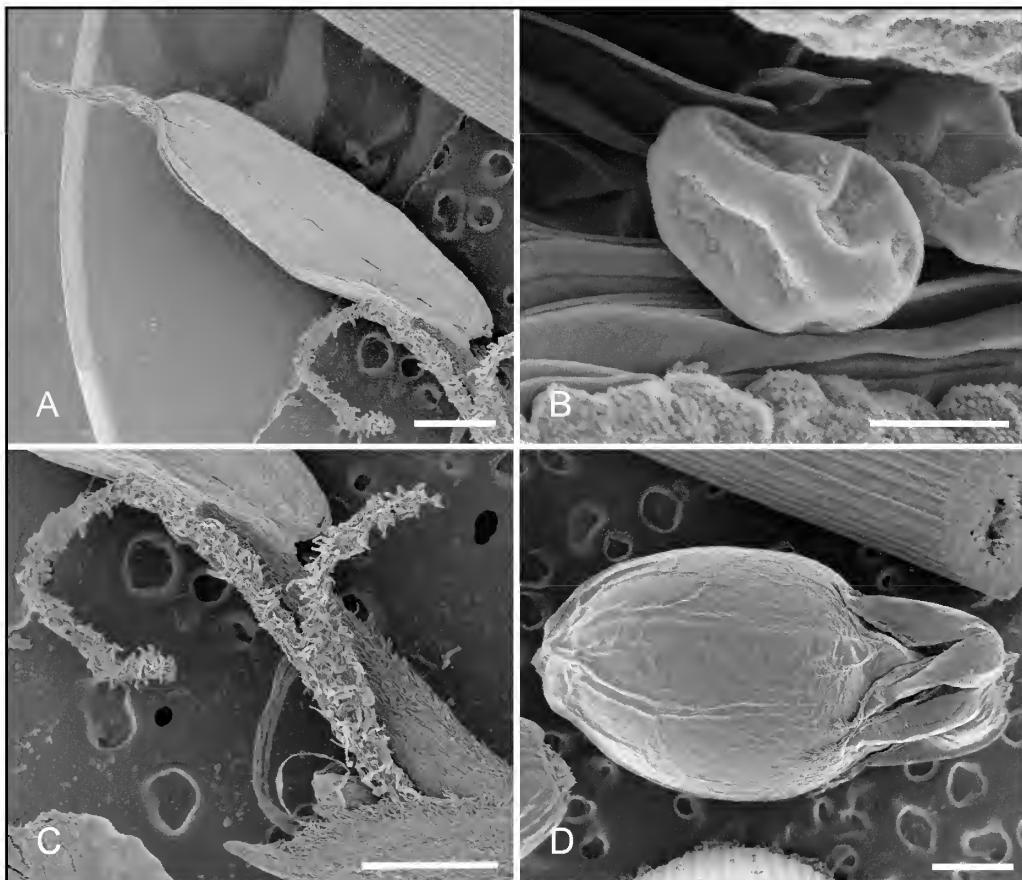


Figure 3. *Lepidosperma apricola* (scanning electron micrographs). A – anther, showing appendage at left; B – pollen (possibly partly collapsed under vacuum); C – style (only two branches visible); D – nut with attached hypogynous scales (A–C – R. Davis 3280; D – G.J. Keighery & N. Gibson 6286, PERTH). Scale bars. A = 500 µm; B = 20 µm; C = 500 µm; D = 500 µm.

Lesueur, NE of Jurien, 19 July 1979, E.A. Griffin 1936 (PERTH); S side Namming Nature Reserve, c. 5 km W Brand Highway on Hunter Road, 10 Sep. 1988, B.J. Keighery s.n. (CANB, PERTH); on S side of reserve boundary track, 4.3 km E of Darkin Road, track leaves road 3.2 km S of Qualen Road. Wandoo Conservation Park, c. 35 km WSW of Beverley, [Plot - YO04], 31 Aug. 1997, G.J. Keighery & N. Gibson 6286 (PERTH); on E side of Numbat Road, 100 m S of Echidna Road, Tutanning Nature Reserve, c. 24 km E of Pingelly, [Plot - WK25], 31 Aug. 1997, G.J. Keighery & N. Gibson 6292 (PERTH); off Crystal Brook Road, Roleystone; S of track, (Plot - CSBK03), 26 Sep. 1996, A. Markey 1188 (PERTH); 13 km E of Williams, 13 Sep. 1975, K.R. Newbey 4795 (PERTH); 27 km NE of Boyup Brook, 25 Jan. 1980, K.R. Newbey 6656 (PERTH); Foxes Lair, 8 May 2005, P. Rose 420 (PERTH); transect 3, Lake Kulicup, on the south-eastern side of lake c. 300 m W along rail line formation from South Kulicup road, c. 25 km E of Boyup Brook, 24 Sept. 2001, A. Webb & B. Muir 466 (PERTH); c. 10.5 km SE of Toodyay on Clackline road, 11 Nov. 1994, K.L. Wilson 8878 & K. Frank (NSW 363989, PERTH); 15 km W of York on the Great Southern Highway to Perth, 11 Nov. 1994, K.L. Wilson 8886 & K. Frank (NSW, PERTH).

*Phenology.* Flowering recorded for May, coincident with the onset of winter rainfall. Fruit maturing in late spring.

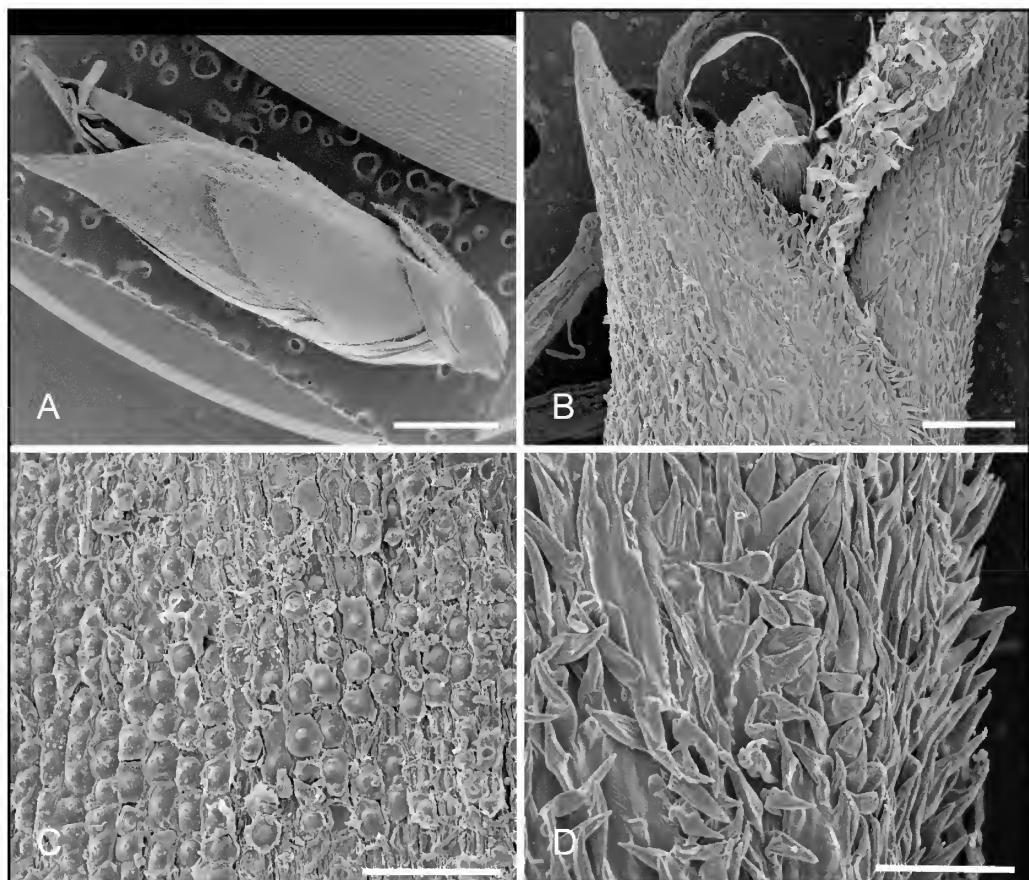


Figure 4. *Lepidosperma apricola* (scanning electron micrographs). A – spikelet; B – glume near apex of spikelet; C – older glabrescent glume surface; D – margin of fertile glume (A – G.J. Keighery & N. Gibson 6286; B–D – R. Davis RD 844, PERTH). Scale bars. A = 1 mm; B = 200 µm; C = 100 µm; D = 100 µm.

**Distribution and habitat.** Relatively widespread in the south-west of Western Australia, from the Darling Range between Mount Lesueur and Walpole, extending inland to Beverley and Narrogin, with an isolated population in Kings Park on the Swan Coastal Plain (Figure 5). A common species in open heath communities that often occur as pockets in jarrah or wandoo forest on laterite, commonly growing in association with *Acacia lasiocarpa*, *A. pulchella*, *A. saligna*, *Allocasuarina fraseriana*, *A. humilis*, *Amphipogon turbinatus*, *Astrolobium foliosum*, *Austrostipa elegantissima*, *Banksia dallanneyi* var. *dallanneyi*, *Beaufortia micrantha*, *Calothamnus quadrifidus*, *Chamaescilla corymbosa*, *Conostylis setosa*, *Corymbia calophylla*, *Daviesia striata*, *Desmocladus fasciculatus*, *Dianella revoluta*, *Eucalyptus marginata*, *E. wandoo*, *Gonocarpus pithyoides*, *Haemodorum laxum*, *Hakea erinacea*, *H. incrassata*, *H. prostrata*, *H. trifurcata*, *Hibbertia hypericoides*, *H. subvaginata*, *Hovea pungens*, *Lepidosperma asperatum*, *L. sp.* Gosnells (A. Markey 1145), *Leptospermum erubescens*, *Macrozamia riedlei*, *Marianthus bicolor*, *Melaleuca cuticularis*, *M. lateritica*, *Mesomelaena tetragona*, *Petrophile seminuda*, *Tetraria* sp. Jarrah Forest (R. Davis 7391), *Tetrariopsis octandra* and *Xanthorrhoea preissii*. Occasionally occurs on sand with *Adenantheros cygnorum*, *Banksia attenuata*, *B. menziesii*, *B. sessilis*, *Eremaea pauciflora*, *Eucalyptus patens*, *Jacksonia furcellata*, *Petrophile seminuda* and *Phlebocarya ciliata*.

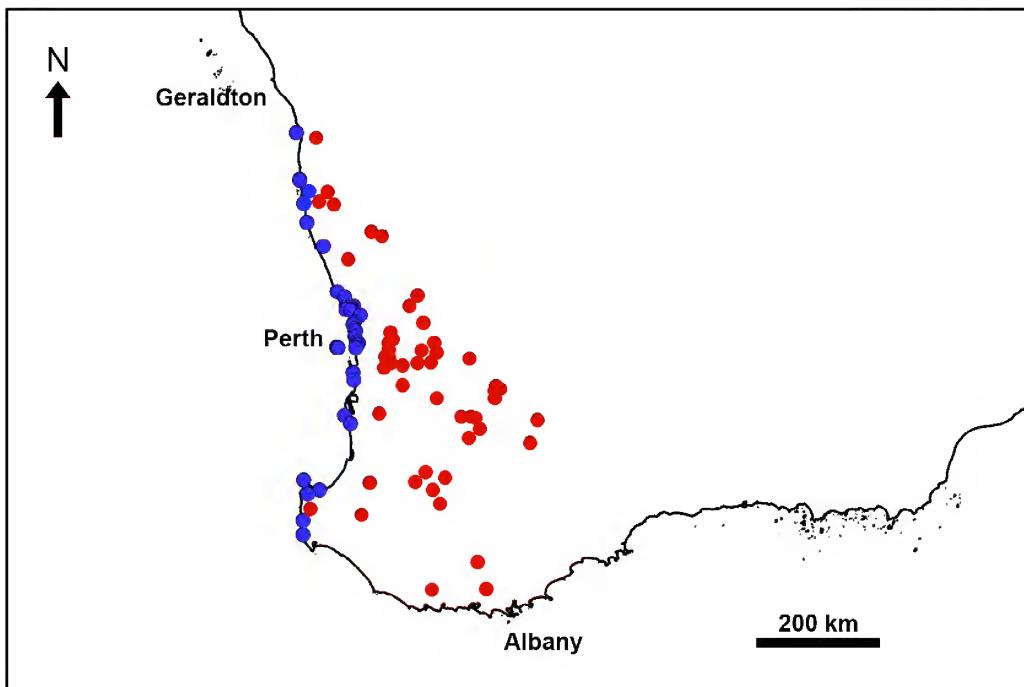


Figure 5. Distribution of *Lepidosperma apricola* (●) and *Lepidosperma calcicola* (○). Map based on data from specimens at the Western Australian Herbarium (<http://florabase.dec.wa.gov.au>) and Australia's Virtual Herbarium (<http://avh.ala.org.au/>).

*Conservation status.* Widespread and not threatened.

*Etymology.* From the Latin *apricus* (sunny) and *-cola* (dweller), in reference to the habitat of this species, which occurs in sunny places in open heath. This differentiates it from the otherwise co-occurring and morphologically similar *L. leptostachyum*, which grows in shady areas in the surrounding jarrah forest.

*Notes.* The overall appearance of this species is strikingly similar to *L. leptostachyum*, the habit and culms being almost identical. The inflorescence form is, however, quite distinctive and the two species are easily separated on this basis and other characters outlined below.

Superficially similar in appearance to *L. leptostachyum*, but *L. apricola* is distinctive in having compact, many-branched inflorescences. The spikelets diverge from the axis of the inflorescence branchlets (appressed in *L. leptostachyum*) giving a very different appearance to the inflorescence (Figure 1H–I). The sheathing bases of the leaves break down, becoming fibrous, and the rhizomes are not as tightly clumping as in *L. leptostachyum*. The leaves also regularly have well-developed blades, whereas they are almost always reduced to a bract-like sheath in *L. leptostachyum*. The two species are genetically dissimilar as indicated by highly divergent molecular sequence data (Barrett 2012b).

Tunnels in the culms of this species have been observed, formed by an unidentified moth larva possibly belonging to the genus *Elachista* (Kaila 2011; Barrett 2013).

***Lepidosperma calcicola* R.L.Barrett & K.L.Wilson, sp. nov.**

*Type:* Bold Park, north of Oceanic Drive, opposite Waldron Drive, Town of Cambridge, Perth, Western Australia, 29 August 2012, R.L. Barrett RLB 7797 (*holo*: PERTH 07984553; *iso*: AD, BM, BRI, CANB, K, MEL, NE, NSW).

*Lepidosperma* sp. B, B.L. Rye, in N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane (eds), *Flora of the Perth region* 890–891 (1987), p.p., (excluding south coast specimens).

*Lepidosperma* sp. D, B.L. Rye, in N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane (eds), *Flora of the Perth region* 891 (1987).

*Lepidosperma* sp. Coastal Dunes (R.J. Cranfield 9963), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au/> [accessed 14 August 2012].

*Tufted perennial*, with adventitious rhizomes which are 50–100 mm long, not or rarely vertical, forming clones to over 1 m across. Rhizome scales almost black at the base, grading to dark chocolate-brown, becoming fibrous with age, 14–32 mm long, 2–3.5 mm diam., closely appressed to the rhizome, usually breaking up and becoming fibrous, the apex subacute. *Culms* and *leaves* distichous; leaf to culm length ratio 0.5–1.2:1; angle of fan (ramet) spread 10–20°. *Leaves* equitant, rigid, erect, compressed biconvex, with very fine ridges on margins and 3–7 deeper ridges at regular intervals across the blade (visible on both fresh and dried material), dull green, not glaucous, with 9–21 stomatal columns per face, 100–590 mm tall, 0.9–2.0 mm wide, 0.3–0.6 mm thick; margins cream or pale straw coloured, almost smooth, not resinous, without hairs; sheath dark chocolate brown, glabrous, the base becoming somewhat fibrous with age, without resin. *Culms* as for leaves but not so compressed, with 9–23 stomatal columns per face, 150–690 mm tall, 1.4–2.8 mm wide, 0.5–1.1 mm thick; margins as for leaves. *Inflorescence* compact, obovoid to obconic in outline, 20–60 mm long, 10–35 mm wide, with few short branches, one lateral branch per node; basal lateral branch 11–32 mm long with 4–25 spikelets; involucral bract 12–51 mm long. *Spikelets* 5.3–7.6 mm long, the upper flower bisexual, the lower flower functionally male. *Glumes* 6–8, keeled, dark reddish brown with narrow, opaque, fimbriate margins, the exposed surface around the keel evenly covered with short, appressed to ascending white hairs, glabrous below and towards margins, the apex acute to apiculate; sterile glumes 4–6; fertile glumes 3.9–6.1 mm long, 1.5–2.0 mm wide. *Hypogynous scales* 6, falling with the nut, broadly triangular, white, 0.75–1.1 mm long; apex acute to attenuate, with scattered short hairs. *Stamens* 3; anthers 2.3–3.0 mm long, 0.6–0.7 mm wide with an apical appendage 0.5–0.7 mm long; filaments 3.7–4.0 mm long; pollen 20–25 µm across, ± spherical, with large irregular surface pits. *Style* 3-fid, unbranched portion 3.5–4.3 mm long, branches 1.5–3.8 mm long; style base continuous with ovary, caducous; stylar cap large. *Nut* cream (pale straw coloured) to pale brown, smooth, with 3 ribs, obovoid, terete in section, 2.3–2.5 mm long, 1.25–1.40 mm wide; epidermal cells irregular, narrowly oblong to round. (Figures 6–9)

*Diagnostic characters.* *Lepidosperma calcicola* is distinctive in having the following combination of characters: compact ramet bases (rarely with vertical rhizomes) with long stoloniferous rhizomes; rhizome bracts that are closely appressed, the apices becoming fibrous and breaking up with age; biconvex culms that are very finely grooved and the margins are smooth; inflorescence compact, lateral branches short; spikelets 5.3–7.6 mm long, glumes dark reddish brown with narrow, opaque, fimbriate margins, the exposed surface around the keel evenly covered with short, appressed to ascending white hairs, glabrous below and towards margins, the apex acute to apiculate.

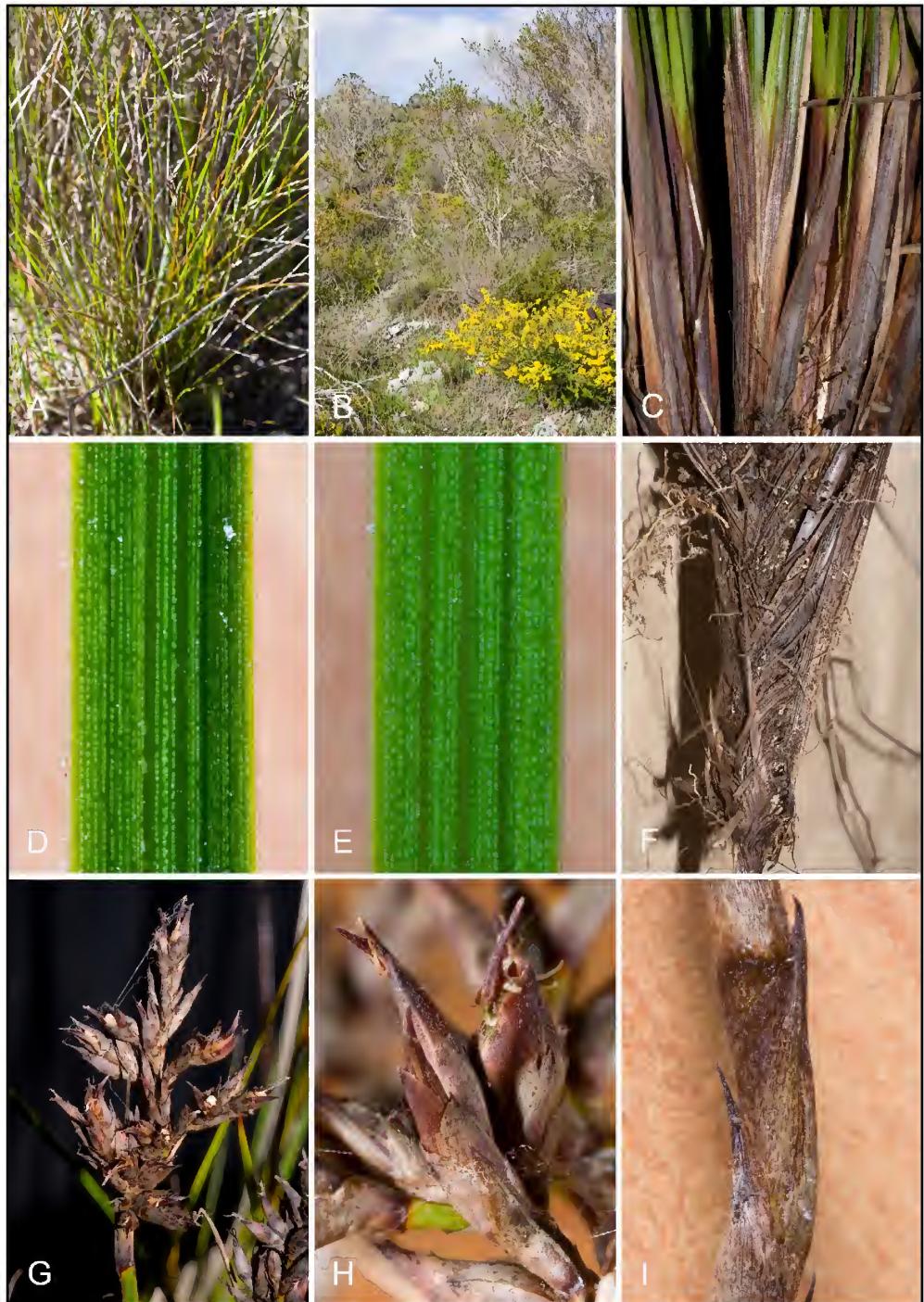


Figure 6. Type location and collection of *Lepidosperma calcicola*. A – habit; B – habitat; C – culms and leaf sheaths; D – culm; E – leaf; F – fibrous bases of leaf sheaths; G – inflorescence; H – spikelets; I – rhizome scale-bracts (R.L. Barrett RLB 7797, PERTH).

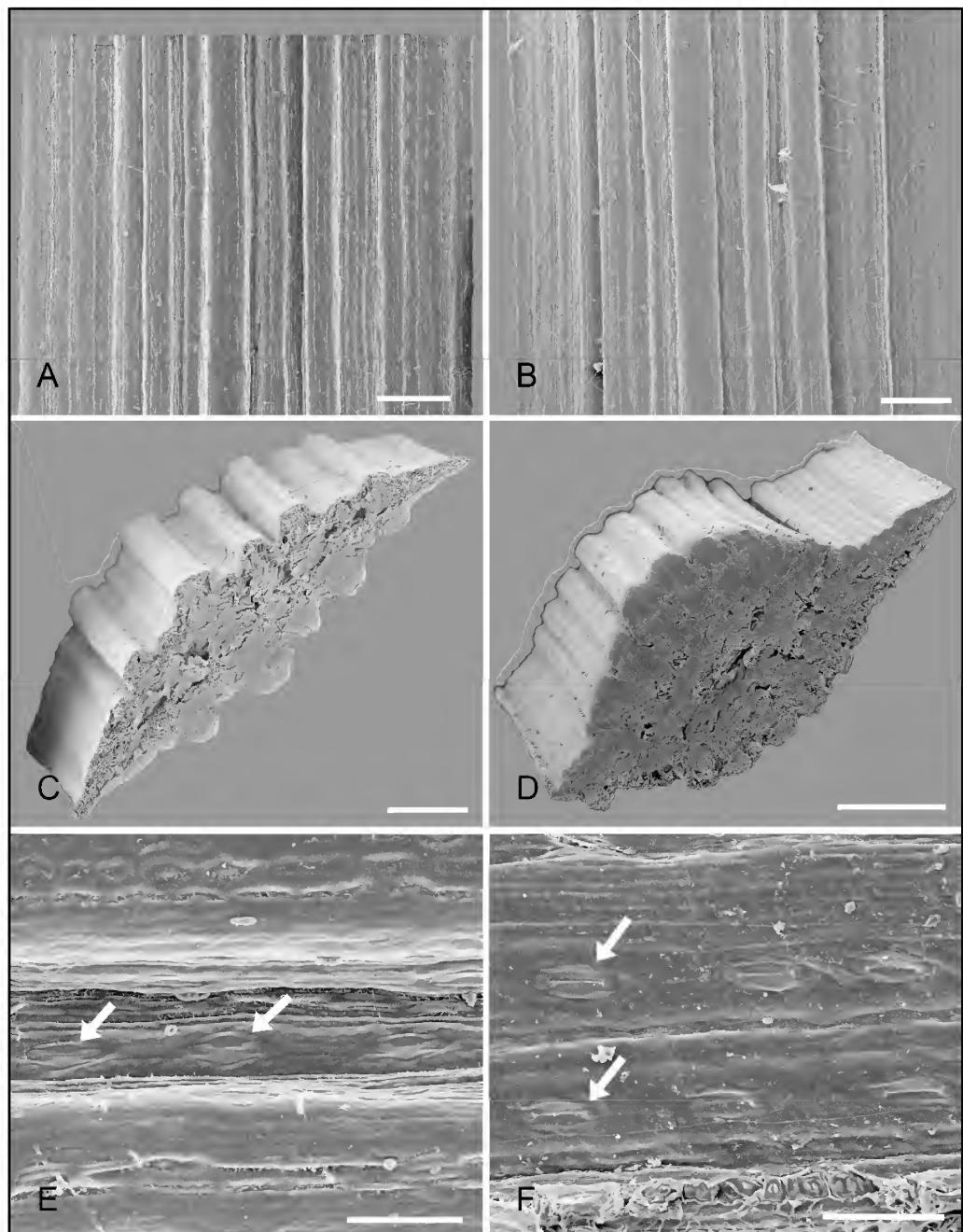


Figure 7. *Lepidosperma calcicola* (scanning electron micrographs). A – leaf surface; B – culm surface; C – leaf section; D – culm section; E – stomata in bottom of culm groove (arrows indicate stomata); F – stomatal columns (arrows indicate stomata) (R.L. Barrett RLB 2660, PERTH). Scale bars. A = 200  $\mu\text{m}$ ; B = 200  $\mu\text{m}$ ; C = 200  $\mu\text{m}$ ; D = 500  $\mu\text{m}$ ; E = 50  $\mu\text{m}$ ; F = 50  $\mu\text{m}$ .

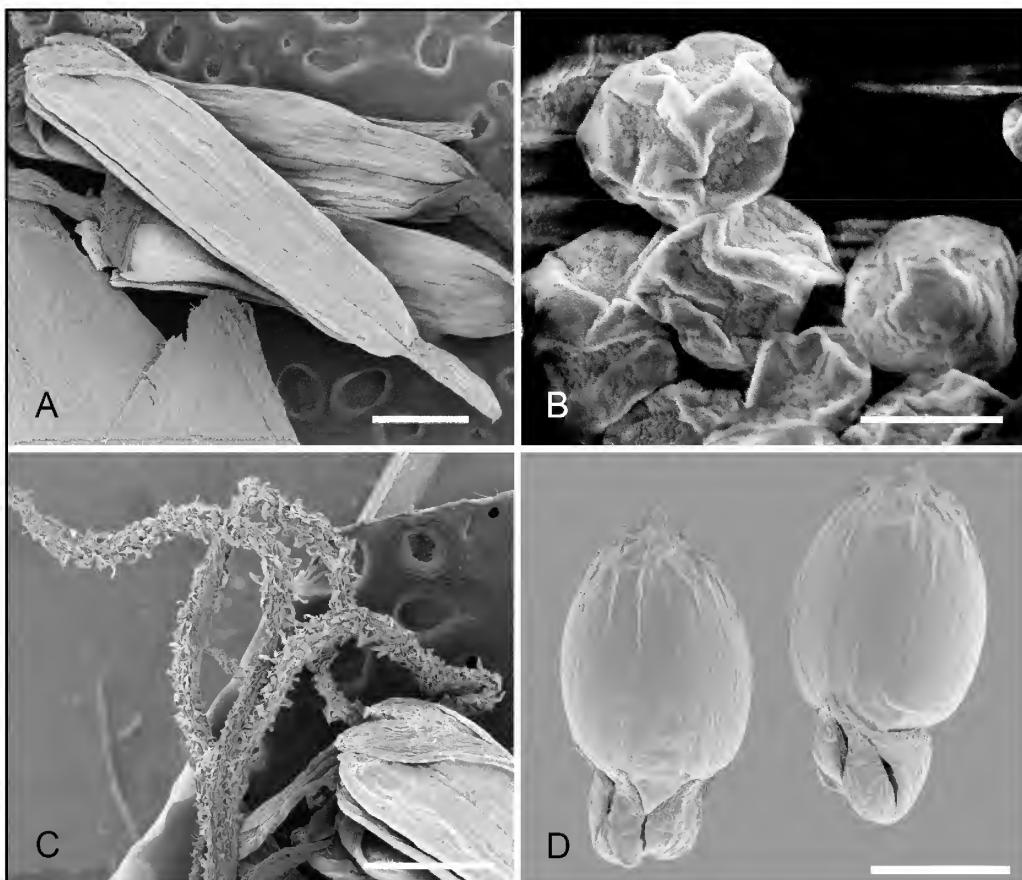


Figure 8. *Lepidosperma calcicola* (scanning electron micrographs). A – anther, showing appendage at right; B – pollen (possibly somewhat collapsed under vacuum); C – style and the three stigma branches; D – nuts with attached hypogynous scales (A, B – R.L. Barrett RLB 2660; C–F – R. Davis RD 844, PERTH). Scale bars. A = 500 µm; B = 20 µm; C = 500 µm; D = 1 mm.

*Selected specimen examined (c. 35 seen).* WESTERN AUSTRALIA: below first lookout on Zamia Trail, 500 m SW of Reabold Hill, Bold Park, Floreat, 8 km W of Perth, 21 Oct. 2003, R.L. Barrett RLB 2658 (PERTH); *loc. cit.*, R.L. Barrett RLB 2659 (PERTH); *loc. cit.*, R.L. Barrett RLB 2660 (PERTH); on S side of old Skyline Drive-In, Bold Park, Floreat, 8 km W of Perth CBD, 21 Oct. 2003, R.L. Barrett RLB 2693 (PERTH); Grigson Lookout, West Coast Highway, N of Jurien Bay, 21 m alt., 14 Aug. 2012, R.L. Barrett & P. Jobson RLB 7788 (AD, NE, NSW, PERTH); Geographe Bay, Darling District, [pre 1898], Miss Bunbury s.n. (PERTH); 5 km S of Leeman, 9 Aug. 1995, R.J. Cranfield 9963 (PERTH); 1 km NE of Guilderton, 21 May 1996, R. Davis RD 844 (PERTH); Cockburn Sound, Rockingham, 8 Sep. 1907, L. Diels 2733 (B); NE of Wedge Island, 14 Nov. 1991, E.A. Griffin 6732 (PERTH); vacant block, 47 Karalundie Way, Mullaloo, c. 1 km inland, 29 Mar. 1986, S.D. Hopper 4799 (PERTH); Reserve 32259; Trigg townsite, 14 km N of Perth, 1 Dec. 1987, G.J. Keighery 9606 (PERTH); ‘In clivulis arenosis haud longe ab ora maritima (Perth)’, 9 June 1840, L. Preiss [*Plantae Preissianae* No. 1785] (BM, LD, P); District Swan: ‘in collibus calcareis prope mare’, Apr. 1901, E.G. Pritzel 267 (BM, DBN, G, NSW, P); Yanchep National Park, 15 m W from 210 m E along Cockatoo Walk Trail, 380 m NNW from intersection of Wanneroo Road and Old Yanchep Road, 24.5 km N of Wanneroo, GSS site 11B, 31 Oct. 2008, D.A. Mickle & M.L. Swinburn 414 (PERTH); 10 km SSE of Cape Freycinet,

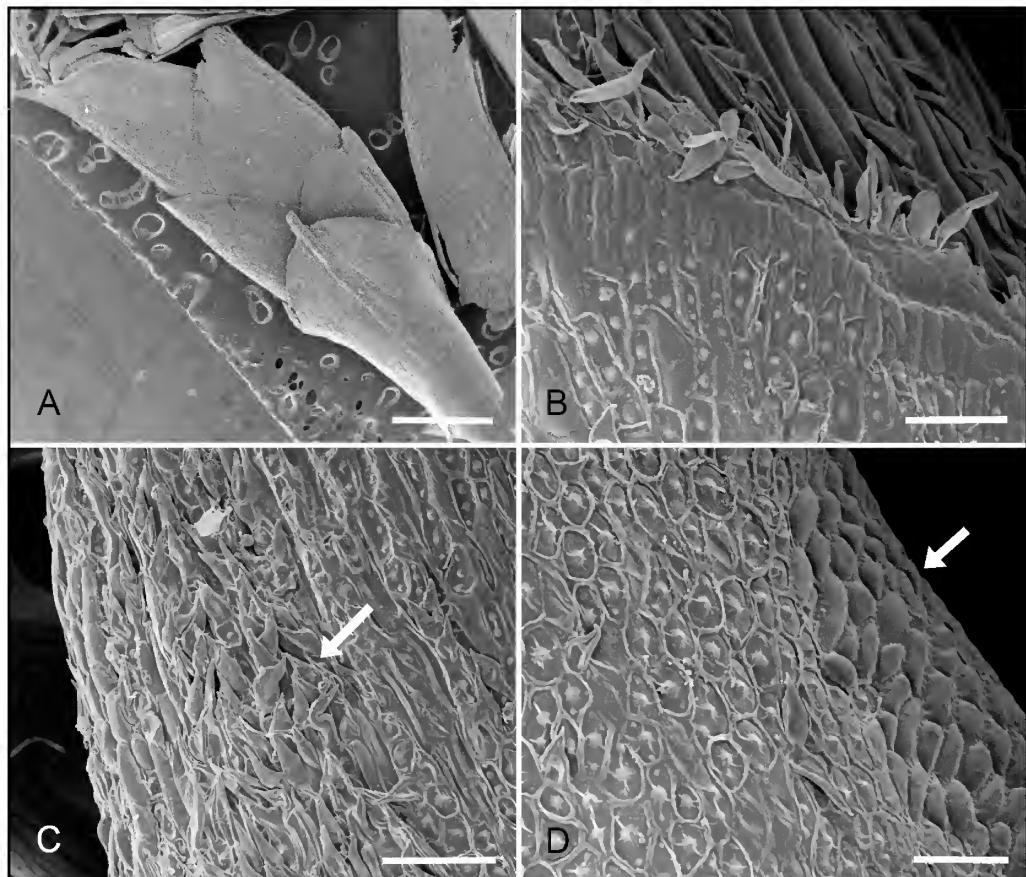


Figure 9. *Lepidosperma calcicola* (scanning electron micrographs). A – spikelet; B – fimbriate margin of spikelet; C – indumentum of fertile glume at keel (arrow indicating hairs); D – indumentum of fertile glume at margin (smooth cells indicated by arrow are the hyaline margin) (R. Davis RD 844, PERTH). Scale bars. A = 1 mm; B = 50 µm; C = 100 µm. D = 50 µm.

c. 20 km NNW of Augusta, 23 Jan. 1980, K.R. Newbey 6651 (NSW; PERTH); 21 km S of Dongara, 26 Oct. 1981, K. Newbey 9380 (PERTH); roadside, hilltop, 0.5 km E of lighthouse, Rottnest Island, 7 June 1999, E. Rippey 076 (PERTH); Rottnest [Island], 15 Nov. 1956, R.D. Royce 5666 (PERTH); Yanchep Beach, Aug. 1960, G.G. Smith s.n. (PERTH); N of Gnangara Road, W side of Lot 46 Maralla Road, locality of Ellenbrook, 28 Oct. 1999, M.E. Trudgen 20781 (PERTH); 7 km N of Leeman on Green Head road, 9 Nov. 1994, K.L. Wilson 8846 & K. Frank (NSW, K, MO, NE, PERTH); outskirts of Cervantes, on track to Lake Thetis, 10 Nov. 1994, K.L. Wilson 8866 & K. Frank (NSW, PERTH).

**Phenology.** Flowering recorded for May, coincident with the onset of winter rainfall.

**Distribution and habitat.** Relatively widespread on coastal dune systems of the Swan Coastal Plain and Geraldton Sandplains, from Bunbury north to Geraldton, on the west coast of Western Australia (Figure 5). A common species on exposed limestone outcrops in coastal heath, extending under open woodland in places on deeper sands. This species occupies a variety of calcareous substrates on stabilised sands and limestone ridges of the Quindalup, Spearwood and Bassendean dune systems. It is

commonly found growing in association with *Acacia lasiocarpa*, *A. saligna* subsp. *saligna*, *A. xanthina*, *Acanthocarpus preissii*, *Acrotriche cordata*, *Banksia attenuata*, *B. menziesii*, *Conostylis aculeata* subsp. *aculeata*, *C. candicans* subsp. *calcicola*, *Conostephium pendulum*, *Corymbia calophylla*, *Dasypogon bromeliifolius*, *Desmocladus asper*, *D. flexuosus*, *Eremaea pauciflora*, *Eucalyptus gomphocephala*, *E. petrensis*, *E. rufa*, *E. todiana*, *Hemiandra pungens*, *Hibbertia hypericoides*, *H. racemosa*, *H. spicata* subsp. *leptotheaca*, *H. subvaginata*, *Kennedia prostrata*, *Kunzea glabrescens*, *Lepidosperma gladiatum*, *Lomandra maritima*, *Machaerina juncea*, *Macrozamia fraseri*, *Melaleuca preissiana*, *M. systema*, *Mesomelaena pseudostygia*, *Nuytsia floribunda*, *Opercularia vaginalis*, *Petrophile macrostachya*, *Phlebocarya ciliata*, *Scaevola anchusifolia*, *Spyridium globulosum*, *Stylium maritimum*, *Templetonia retusa*, *Thomasia triphylla*, *Trymalium ledifolium*, *Xanthorrhoea brunonis* and *X. preissii*.

*Conservation status.* Widespread and not threatened.

*Etymology.* From the Latin *calci-* (lime) and *-cola* (dweller), in reference to the specific habitat of this species on coastal limestone and calcareous dunes.

*Notes.* As described here, this is a variable taxon, commonly forming short tussocks with very slender culms on exposed limestone, increasing in height and with broader culms when growing on deeper sands. No consistent differences have been identified and this variation is considered to be most likely ecotypic. It is possible that there are two genotypes involved, generally corresponding to the age of the dunes on which they occur, the shorter forms occurring on the younger Quindalup Dune System versus the taller form on the older Bassendean Dune System. The two forms can co-occur where these dune systems meet (e.g. in Bold Park, Perth: R.L. Barrett RLB 2658 and R.L. Barrett RLB 2660). The tall form was described by Rye (1987) under the name *L. sp. B* (excluding south coast specimens) while the small form was described as *L. sp. D*. Further investigation should be undertaken to determine whether there are ploidy differences between these forms.

Generally similar in appearance to *L. squamatum*, *L. calcicola* is distinctive in having compact ramet bases (rarely with vertical rhizomes) with long stoloniferous rhizomes. These vertical rhizomes do not appear to form even in the youngest dune systems that are more prone to sand burial. The rhizome bracts are closely appressed, with the apices breaking up, becoming fibrous. The biconvex culms are very finely grooved and the margins are smooth (several very distinct grooves in *L. squamatum*). The inflorescence is quite compact, with short lateral branches (inflorescence somewhat looser, more elongate in outline in *L. squamatum*). It differs from the related *L. scabrum* by the compressed (vs. sub-terete), non-scabrid (vs. scabrid) culms and reduced (vs. multi-branched and tangled) inflorescence.

This species is known to be a host plant for the graceful sun-moth (Barrett 2013).

### Acknowledgements

Zoe Davies, Terry Macfarlane, Juliet Wege and an anonymous referee are thanked for comments on the manuscript. The staff at Bold Park, and Kings Park and Botanic Garden (Botanic Gardens and Parks Authority), are thanked for their assistance with bushland surveys. Staff at the Western Australian Herbarium are thanked for their support and for making facilities available to complete this study. Aspects of this research were supported by Worsley Alumina Pty Ltd and Alcoa World Alumina Australia. Particular thanks to Haakon Nielssen, Stephen Vlahos and David Willyams for enabling mine site access and transport. Peter Jobson, Giuseppe Messina and Ben Anderson assisted with fieldwork. Myles Menz assisted with the creation of the map.

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## A revision of the south-western Australian genus *Astartea* (Myrtaceae: Chamelaucieae)

**Barbara L. Rye**

Western Australian Herbarium, Department of Environment and Conservation, Locked Bag 104,  
Bentley Delivery Centre, Western Australia 6983  
Email: Barbara.Rye@dec.wa.gov.au

### Abstract

Rye, B.L. A revision of the south-western Australian genus *Astartea* (Myrtaceae: Chamelaucieae). *Nuytsia* 23: 189–269 (2013). *Astartea* DC. is a long-established, taxonomically difficult genus closely related to *Cyathostemon* Turcz. and *Hypocalymma* (Endl.) Endl. It is restricted to damp habitats of the South West Botanical Province of Western Australia. In this revision of the genus, 22 species are recognised, including 11 new species (*A. cicatricosa* Rye & Trudgen, *A. decemcostata* Rye, *A. eobalta* Rye, *A. graniticola* Rye & Trudgen, *A. middletonii* Rye, *A. montana* Rye, *A. onycis* Rye & Trudgen, *A. schaueri* Rye & Trudgen, *A. reticulata* Rye, *A. transversa* Rye and *A. zephyra* Rye & Trudgen) and one new subspecies (*A. aspera* Schauer subsp. *riparia* Rye). A presumed hybrid between *A. arbuscula* (R.Br. ex Benth.) Rye and *A. corniculata* Schauer is also described. Distinguishing characteristics, insect associations and other aspects of the biology of *Astartea* are discussed and illustrated.

### Introduction

The myrtaceous genus *Astartea* DC. belongs to the large tribe Chamelaucieae DC. and is restricted to damp habitats in the south-west of Western Australia. It is a well defined genus, with many similar species presumably resulting from a relatively recent and rapid radiation. Consequently, it is taxonomically difficult, with many qualitative characteristics of the leaves and flowers being remarkably constant. Some quantitative characters, such as flower size, stamen number and ovule number, are highly variable in the genus and potentially valuable in distinguishing species; however, a large amount of quantitative variation also occurs within some species. With many species overlapping in range and often occurring in close proximity, there is ample opportunity for hybridisation to further complicate the taxonomy of the genus.

Although *Astartea* was one of the earliest genera of its tribe to be named, it has not been revised since Bentham (1867) responded to the taxonomic difficulty of the genus by synonymising most of the previously published taxa under the type species, *A. fascicularis* (Labill.) DC. As a result, the authors of many flora surveys and other studies (e.g. Dodd *et al.* 1984; Lyons 1988; Yeates 1992; Richardson *et al.* 2006) have recorded any *Astartea* species they encountered as *A. fascicularis*.

The aim of the taxonomic revision presented here is to name all new taxa for which adequate collections and other data are available, to provide a workable key for the identification of all named taxa, and to

briefly examine the biological significance of a range of morphological characters observed in *Astartea*. Future studies are likely to increase the number of species recognised beyond the 22 described here.

### Taxonomic history

The first specimen of *Astartea* was apparently collected on Observatory Island, Archipelago of the Recherche, in December 1792 by Jacques de Labillardière, the naturalist on a French expedition led by d'Entrecasteaux (see Duyker 2003). Labillardière (1806) named the species *Melaleuca fascicularis* Labill. However, De Candolle (1828) created the new genus *Astartea* for this species because it differed from *Melaleuca* L. in having pedicellate flowers and in having stamen fascicles opposite the sepals rather than the petals (De Candolle 1842).

Over thirty years elapsed before a second species of *Astartea* was described, this one placed in the genus *Baeckea* L. under the name *B. affinis* Endl. (Endlicher 1837). Schauer (1843, 1844) renamed Endlicher's species as an *Astartea* and described six new species. A further two species descriptions were published by Turczaninow (1852), although one of these taxa is now regarded as a synonym.

During the same period that the number of described species of *Astartea* rose to nine, the related genera *Hypocalymma* (Endl.) Endl. (Endlicher 1837, 1840) and *Cyathostemon* Turcz. (Turczaninow 1852) were established. The latter genus was unknown to Schauer, who died in 1848; however, he made a significant contribution to the taxonomy of *Hypocalymma* as well as *Astartea* and was evidently aware of morphological similarities between the two genera. In his systematic ordering of the myrtaceous genera, Schauer (1843, 1844) placed *Astartea* last, directly after *Hypocalymma*. It was not until 2002, when the first molecular data were published (Lam *et al.* 2002), that the close relationship between *Astartea* and *Hypocalymma* was again recognised.

Mueller (1859, 1860) broadened the delimitation of *Astartea* when he named *A. ambigua* F.Muell. and *A. intratropica* F.Muell., both of which showed marked morphological differences from the previously named *Astartea* species. The latter species was also atypical in occurring in the Northern Territory as all other species were restricted to the south-west of Western Australia. The former species has now been transferred to *Cyathostemon* (Rye & Trudgen 2012) while the latter has been placed in the genus *Seorsus* Rye & Trudgen (Rye & Trudgen 2008).

In his treatment of *Astartea* for *Flora Australiensis*, Bentham (1867) recognised three species, including both of Mueller's atypical species. He synonymised all south-western Australian species with antisepalous fascicles under the type species *A. fascicularis*, although he noted that this broadly circumscribed taxon was extremely variable. Bentham also named two species (*Baeckea arbuscula* R.Br. ex Benth. and *B. astarteoides* Benth.) that are now considered to be typical members of *Astartea* but which have such low stamen numbers that antisepalous fascicles are rarely, if ever, formed. He was concerned, however, that *Astartea* could only be distinguished by having its stamens 'more or less united at the base' (Bentham 1867: 89) and was well aware (see Bentham 1868: 115, 134) that reliance on this single character difference between *Astartea* and *Baeckea* resulted in an artificial separation of the two genera.

Although Niedenzu (1893) synonymised *Astartea* under *Baeckea*, Australian botanists continued to follow the generic limits given in *Flora Australiensis*. Gardner (1927, 1942) named two more atypical species, *A. heteranthera* C.A.Gardner and *A. clavifolia* C.A.Gardner. Like the two species named previously by Mueller (1859, 1860), the former of Gardner's species is now placed in *Cyathostemon* and the latter in *Seorsus*.

Since 1867, no new members of *Astartea* s. str. have been formally named except for one variety described by Domin (1923). The need for additional species to be recognised in the genus was noted in the *Astartea* treatment for *Flora of the Perth Region* (Rye 1987) although the *status quo* of recognising only one species, as *A. fascicularis*, was the only practical option at that time.

Between 1994 and 1997, Malcolm Trudgen established informal names for ten of the taxa with antisepalous fascicles of stamens. Most of these informal names were used in *Flora of the south west* (Wheeler *et al.* 2002), which gave brief descriptions for nine of the twelve species now recognised in the region covered by that flora.

### Current study

The current study of *Astartea* began in 2002 with the examination of type material. This led to the reinstatement in *FloraBase* (Western Australian Herbarium 1998–) and Rye (2006) of most of the species named by Schauer (1843, 1844) and Turczaninow (1852). New combinations were also made (Rye 2006) for three species of *Astartea* that had been described as members of the genus *Baeckea*. Although these published names have now replaced half of the informal names that were in use in 2002, the number of species known by informal names has risen as additional new taxa have been delimited.

The circumscription of *Astartea* adopted in recent publications (Rye 2006; Rye & Trudgen 2008, 2012) agrees with Turczaninow's (1852) concept of the genus, from which he excluded *Cyathostemon*.

### Methods

Where possible, flower diameter was measured on fresh material in the field; this was found to correspond well with measurements made on the same material after pressing. All other measurements were made from herbarium specimens. Holotypes of the new species are all housed at PERTH.

Leaf descriptions were taken from typical mature leaves, excluding the single leaf that often subtends each fascicle of leaves, as this is more flattened and broader than usual. Length measurements of bracteoles were taken from the oldest buds on which they were still present, or from flowers if they were sufficiently persistent. Measurements of peduncles, pedicels and styles were also taken when they were fully mature, i.e. in late flower or in fruit. It is particularly important for the pedicel to be measured after it has fully extended as its length relative to that of the peduncle increases as it matures.

Only the outermost two sepals were measured as these are the longest and have the greatest development of the dorsal ridge or horn. All style measurements given here include the immersed portion, requiring a fully mature flower or fruit to be dissected to reveal the complete style. Fruit measurements were taken from mature fruits before they either dehisce or are shed unopened from the plant. Fruit length excludes any attached floral parts but the width includes the adnate hypanthium.

Distributions were plotted, using DIVA-GIS Version 5.2.0.2, from data obtained from *FloraBase* (Western Australian Herbarium 1998–), onto maps showing the *Interim Biogeographic Regionalisation for Australia* (IBRA 6.1) regions (Department of the Environment, Water, Heritage and the Arts 2008).

Multiple images of flowering stems, seeds and insect scales were taken with a Nikon Digital Camera Head (DS-5M) controlled by a DS Camera Control Unit (DS-L1) and a montage of the images was collated using Synoptics Auto-Montage Pro Version 5.03.0061 software.

## Morphology

This section outlines the morphological characters that either define the genus or are of value in delimiting its species. Many of these characters are illustrated in Figures 1–4.

### Vegetative characters

*Habit and indumentum.* *Astartea* species have a wide variety of growth forms, ranging from dwarf shrubs 0.1–0.4 m high to small trees, reaching a maximum height of at least 5 m. Many species have lignotubers (Figure 1A) but others are single-stemmed or spread laterally by suckering. See the *Growth forms* section below for more details. All parts of the plants are glabrous and many of them are dotted with oil glands.

*Young stems.* Young stems are 4-angled (Figure 1F) and sometimes slightly to distinctly winged along each angle, this character becoming pronounced in *A. laricifolia* Schauer (Figure 1E). Crown-shaped outgrowths, consisting of an oil gland surrounded by a protruding rim with a number of projections, occur on young stems of *A. aspera* Schauer (Rye & Trudgen 2008: Figure 1A) and *A. muricata* Turcz. (Figure 2A). They often also occur on the leaves and peduncles of those species, but are not as prominent there as on the stems.

*Leaf fascicles.* Leaves tend to be densely clustered on short side shoots (i.e. where new branchlets form in the axils without elongation of internodes) in most species, with some species showing a much stronger tendency for this than others. For example, leaf fascicles are well developed in *A. glomerulosa* Schauer (Figure 1C) but widely spaced leaves are more common in *A. affinis* (Endl.) Rye (Figure 1B). During growth spurts, however, all species produce some rapidly growing stems with widely separated pairs of leaves.

*Leaf morphology.* All species have a narrow, entire blade, which is generally thicker than wide and has its maximum width and thickness towards the apex. In most cases the blade has sharply defined angles between a deep abaxial surface and flat to grooved adaxial surface. The petiole is short and often poorly defined. Small hair-like processes, which are presumed to be reduced, divided stipules (see Johnson & Briggs 1984: 741), are often present in the axils of young leaves (Figure 3C).

### Inflorescence

*Flower arrangement.* Flowers are usually solitary in the axils. They are subtended by a pair of bracteoles, which are usually borne at the junction (see Figure 3D) of a dorsiventrally compressed peduncle (sometimes compressed only towards the base) and a more or less terete pedicel. Pedicels are sometimes absent in the two species (*A. arbuscula* (R.Br. ex Benth.) Rye and *A. transversa* Rye) with the smallest flowers. In most species they tend to be shorter than, sometimes to as long as, the peduncles; however, in *A. aspera* and *A. laricifolia* they tend to be distinctly longer than the peduncles. *Astartea muricata* is unique in having up to three flowers on each peduncle, occasionally with more than one peduncle per axis, although some specimens have uniformly 1-flowered axils. Figure 2A illustrates a 2-pedunculate, 4-flowered axil in this species, the abaxial peduncle 1-flowered and the adaxial peduncle 3-flowered. *Astartea zephyra* Rye & Trudgen includes one atypical specimen (*D. Cooper* 162) in which there are occasionally two peduncles per axil, both 1-flowered.

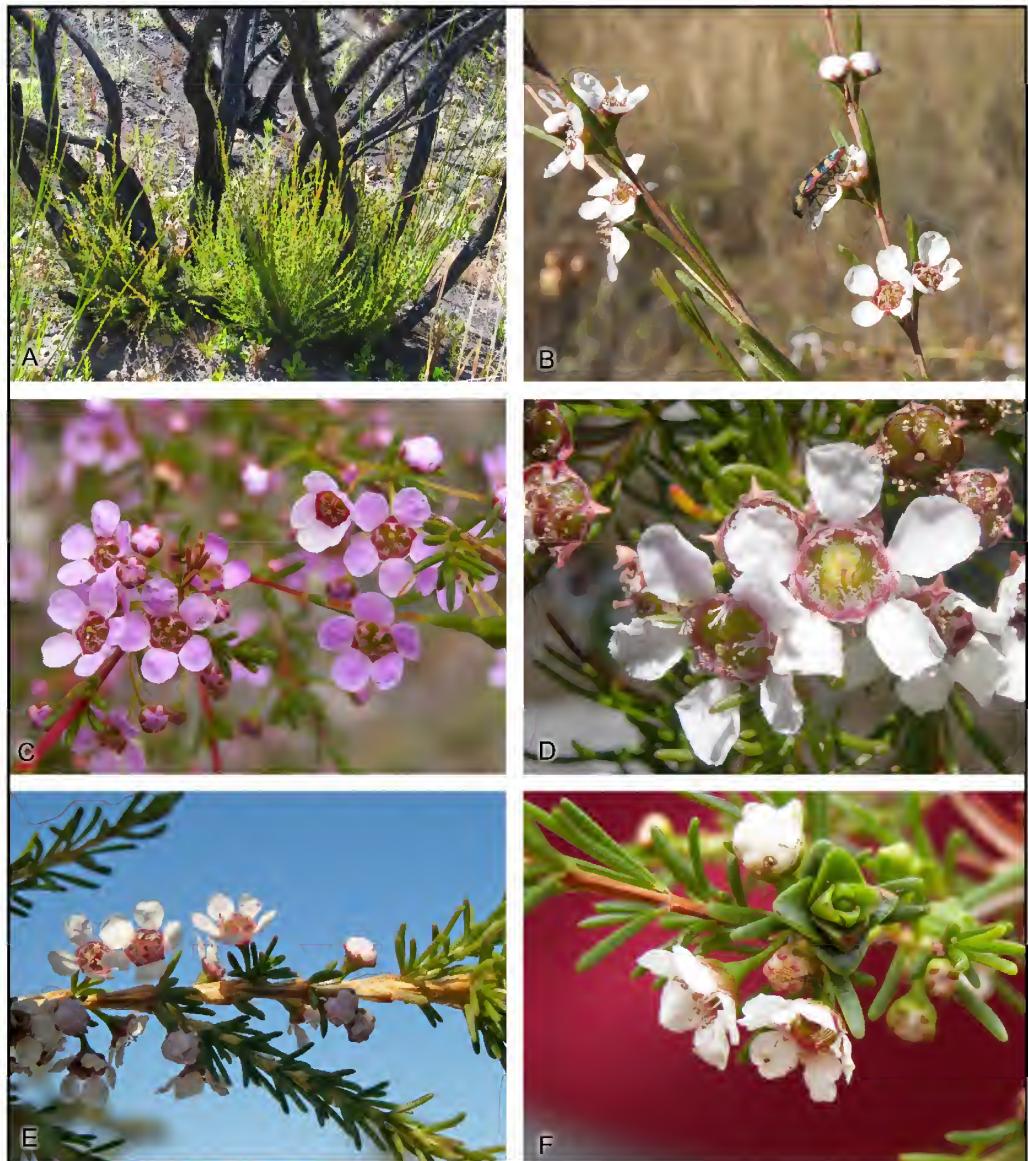


Figure 1. Field images. A – regrowth from *Astartea lignotuber* at Moorialup Nature Reserve in January 2010; B – flowering stem of *A. affinis* with jewel beetle; C – buds and flowers of *A. glomerulosa*; D – *A. granitica* flowers and fruits; E – winged flowering stems of *A. laricifolia*; F – 4-angled flowering stems and galled shoot of *A. scoparia*. Images from B.L. Rye 221202 (B); B.L. Rye 221210 & R.W. Hearn (C); B.L. Rye 221240 & R.W. Hearn (D); B.L. Rye 230145 & R.W. Hearn (E) and B.L. Rye 221224 & R.W. Hearn (F). Taken by P.J. Rye (A–D, F) and B.L. Rye (E).

**Bracteoles.** Bracteoles overlap at first, enclosing the young buds, which may have little or no pedicel. The apex of the bracteole tends to be hooded (Figure 3D) and sometimes has a subterminal point (Figure 3H). As buds mature the pedicel tends to elongate much more markedly than the peduncle and the bud usually emerges from its subtending bracteoles (Figure 3C) well before anthesis. Usually the bracteoles are caducous or deciduous, with one (Figure 3D) or both (Figure 3A) shed before the buds reach maturity. However, in a few species such as *A. schaueri* Rye & Trudgen, the bracteoles



Figure 2. Flowering stems. A – crown-like outgrowths and a multi-flowered axil of *Astartea muricata*; B – part of branchlet with buds, flowers and fruits of *A. transversa*. Scale bars = 1 mm. Images from R.J. Cranfield 4506 (A) and E.A. Griffin 4073 (B). Prepared by A.R. Williams.

can be quite broad and continue to enclose older buds (Figure 3H). If the bracteoles separate from one another without falling they may occasionally persist after anthesis.

### Flowers

**Merosity.** All species have primarily 5-merous flowers, although occasional 4-merous flowers may be produced, sometimes apparently in response to stress; these tend to be the first or last flowers opening on an individual plant. In large-flowered species there may also be occasional 6-merous flowers. In 5-merous buds, the petals overlie one another in a layer five thick above the nectariferous ovary summit. The innermost petal is the most crinkled by the anthers or stamen fascicles it covers and the outermost one smoothest, a difference that is visible in the opened flowers (Figure 1C).

**Size.** Flowers range from moderately large in relation to other Chamaeleacieae down to the ‘excessive minuteness of the flowers’ noted by Bentham (1867: 79) in *A. arbuscula*. Flowers of *A. arbuscula* are 1.5–2 mm in diameter, with petals only 0.4–0.6 mm long, an exceptionally small size for Myrtaceae. The largest flowers occur in two species that grow on granite outcrops, with the petals of *A. granitica* Rye & Trudgen (Figure 1D) 4–6 mm long, ten times larger than those of *A. arbuscula*, and the flowers of *A. middletonii* Rye up to 15 mm in diameter.

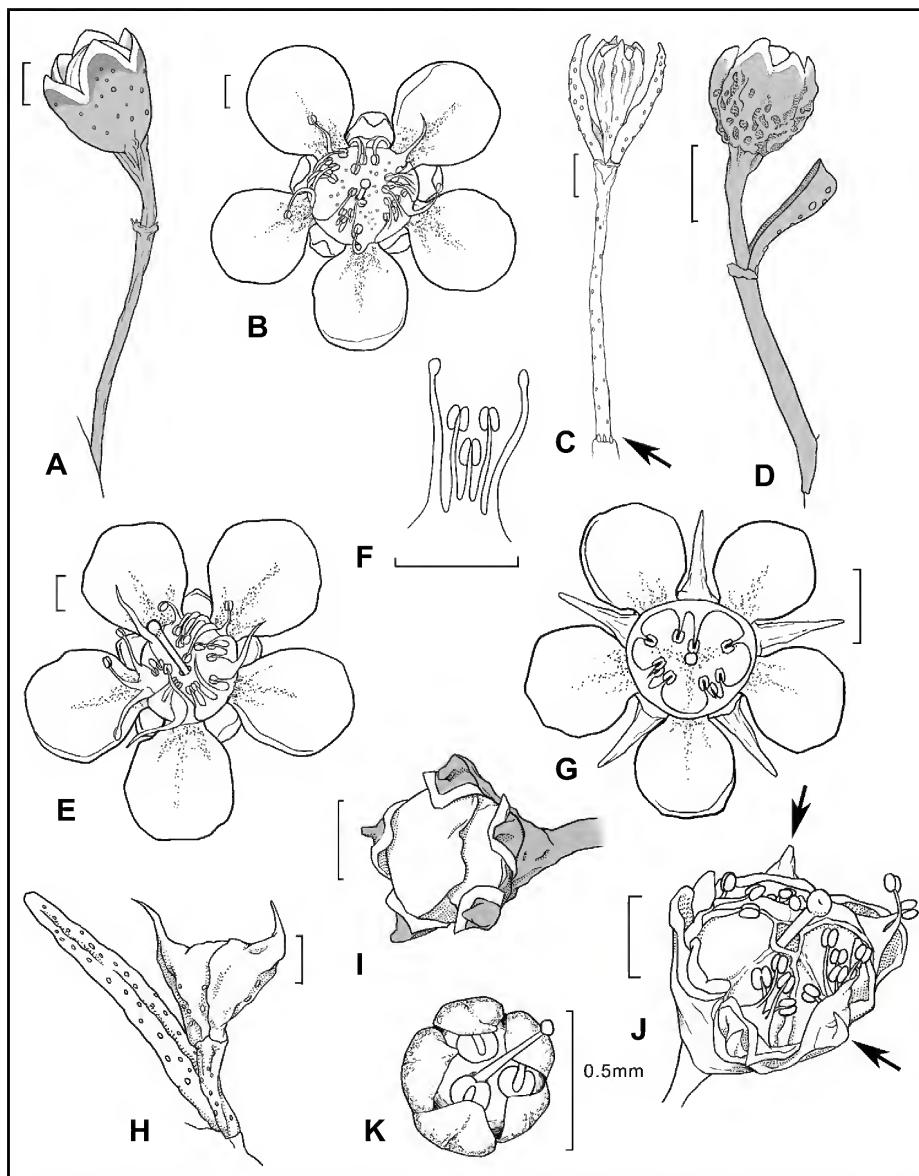


Figure 3. Illustrations of *Astartea* buds, flowers and fruits. A, B – *A. cicatricosa*. A – flower bud after bracteoles have been shed; B – flower; C – *A. decemcostata* flower bud subtended by two bracteoles, with stipules (arrowed) at the junction of the peduncle and the stem (the subtending leaf has been removed); D–F – *A. montana*. D – flower bud with only one bracteole persisting; E – flower; F – fascicle with lateral staminodes; G – *A. onycis* flower; H–J – *A. schaueri*. H – peduncle, subtending leaf and bracteoles enclosing bud; I – flower bud; J – fruit (with outer horns arrowed); K – *A. transversa*, top view of fruit with three stamens. Scale bars = 1 mm (A–J); 0.5 mm (K). Drawings from M. Bennett 25 (A, B); M. Hislop 2888, S. Barrett & J.A. Cochrane (C); G.J. Keighery 2595 (D, F); M. Hislop 2523 (E); G.J. Keighery 13464 (G); A.R. Amels 995 (H); B.G. Hammersley 3245 (I); R. Davis 4791 (J) and G.J. Keighery 8398 (K). Prepared by L.N. Rye.

*Colour.* Flower colour shows relatively little variation within the genus, varying in most species either from white to pale pink or from pale pink to medium pink, so that most species can be categorised as predominantly white-flowered or predominantly pink-flowered. The only variation from this, a very deep pink colour, is found in the very small flowers of some specimens of *A. arbuscula* and *A. arbuscula × corniculata*.

*Hypanthium.* Hypanthium texture (in the dried state of herbarium specimens) varies from fairly smooth but with slightly protruding oil glands (Figure 3A) to rugosely reticulate-pitted (Figure 3D) or ribbed (Figure 3C).

*Sepals and petals.* Sepals have a petaline margin surrounding the herbaceous base, which varies from smooth (Figure 3A) to deeply ridged, with the ridge often protruding into a short (Figure 3I) or long (Figure 3G) horn. Sepals tend to be more erect than the petals, which open widely at anthesis (e.g. Figure 3B), although the horn (when present) is sometimes widely spreading (Figure 3G). The partially herbaceous sepals persist in fruit whereas the more delicate petals are shed before the fruit reaches maturity.

## Androecium

*Ontogeny.* Carrugan and Drinnan (2000) showed that the stamens of one *Astartea* species\* are initiated opposite the petals, but in later development form a ring and, later still, become concentrated opposite the sepals. A similar developmental sequence was found in *Hypocalymma cordifolium* (Lehm.) Schauer, but stopping one stage earlier in that species so that the stamens remain in a uniform ring.

*Stamen number.* Stamen numbers are lowest (3–5 per flower) in *A. transversa* and highest (37–60 per flower) in *A. middletonii*. Infra-specific variation in stamen number is often considerable, with differences occurring not only between populations and individuals of each population, but also between flowers on each plant and between sepals in the same flower (e.g. Figure 3G).

*Stamen arrangement.* Where stamen number is only three to five per flower, each stamen is solitary, situated opposite the centre of a sepal, and well separated from adjacent stamens (see the 3-staminate fruit in Figure 3K). Most species of *Astartea* have more numerous stamens with some (Figure 3G) or all of them (Rye 1987: Figure 140C) united into fascicles opposite each sepal. If there are only two or three stamens opposite a sepal, they do not necessarily form an obvious fascicle; if they are well separated they are either completely free or only shortly united. Whether or not these few stamens form a fascicle may vary between flowers on the same plant and also between sepals on the same flower. Whenever there are four or more stamens opposite a sepal, they always form an obvious fascicle.

Where stamen numbers are high in *Astartea*, especially when 35–60, the stamens are arranged in more than one series, but in species with low numbers of stamens the inner series is absent or only slightly developed. Stamens of the inner series are noticeably shorter than adjacent stamens of the outer series. Where stamen numbers are high there is a tendency for a solitary stamen to be present opposite some or all of the petals in addition to the antisepalous fascicles. In this case there may be a slight connection

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\*given as *A. heteranthera*=*Cyathostemon heterantherus* (C.A.Gardner) Rye & Trudgen, but probably *A. scoparia* Schauer judging from the images and the fact that this species is described as having 30 stamens.

also between the antisepalous fascicles and the solitary antipetalous stamens, resulting in a complete ring of stamens fused at the base (Figure 3E).

*Staminode number and arrangement.* Whereas most *Astartea* species lack staminodes or only occasionally produce a few of them, *A. fascicularis* and *A. montana* Rye have up to ten staminodes per flower. Staminodes occur on the margins of antisepalous fascicles or directly opposite petals.

*Fascicle structure.* Each antisepalous fascicle, or each series within the fascicle, has the longest filaments towards the outside, i.e. closest to the petals, and antipetalous stamens are also long. Usually the outermost filaments of each fascicle are united for the shortest distance, as shown for the marginal staminodes in Figure 3F, with the united part of the fascicle deepest at the centre. Occasionally, however, the fascicle has a central cleft (Figure 3B, arrowed).

*Anthers.* Anthers have two parallel loculi and a free connective gland in a subterminal, dorsal position. The base of the anther is attached to the filament and each loculus releases its pollen through a longitudinal slit. Apart from variation in the orientation of the loculi from introrse to latrorse, the anther morphology in *Astartea* is fairly consistent.

## Gynoecium

*Number of loculi.* In species with a normally 3-locular ovary, there are often a few flowers that have a 2- or 4-locular ovary. Only a few species are characteristically 2-locular; in these one of the loculi may be reduced and sterile so that the ovary is functionally 1-locular.

*Orientation and symmetry.* Most *Astartea* species, like most other members of the tribe Chamaeleae, have radially symmetrical flowers with no obvious orientation of the ovary loculi in relation to the stem. An exception is *A. arbuscula*, which has a functional, abaxial loculus and a greatly reduced, non-functional, adaxial loculus. The bilaterally symmetrical flowers have a petal directly opposite the axis (i.e. adaxial) and a sepal on the abaxial side. The opposite orientation, i.e. with a sepal directly opposite the axis, is found in *Corynanthera* J.W.Green and in a few species of *Micromyrtus* Benth. that have a very compressed hypanthium. Owing to the unequal development of the two loculi in *A. arbuscula*, the style is off-set towards the adaxial side of the flower.

*Ovules.* Ovule number varies from one per flower in *A. arbuscula* to a maximum of about 60 in *A. fascicularis*. Each placenta of the latter species has 14–23 ovules arranged in two close rows along its length and radiating at both ends.

*Style.* The style is much longer in fruit (e.g. Figure 3K) than when the flowers are newly opened (Figure 3B,G). It is dark red at maturity on the part that is exposed to sunlight but much paler on the enclosed basal part. The base of the style is usually in a deep cylindrical depression that reaches the level of the placentas. The depression is reduced in 2-locular ovaries that have one loculus abortive, although the base of the style still reaches the level of the single functional placenta, which is tilted towards the top of the ovary.

*Stigma.* In flowers with a 3-locular ovary, the peltate stigma is more or less circular from top view, although it is slightly divided into three regions (Rye 1987: Figure 140F).

## Fruiting characters

*Fruits.* In most species the fruits are predominantly 2- or 3-valvate and about half-inferior (see the 3-valvate fruit in Figure 3J). The extreme base of the style may become split into three after the fruit opens fully, having been torn by the three separating parts. Indehiscent fruits, like the one illustrated in Figure 3K, are two-thirds to three-quarters inferior. Seed numbers vary from one per fruit, which is a common occurrence when the fruit is indehiscent, to many per fruit, with up to five or rarely more per loculus.

*Typical seeds.* *Astartea* seeds are small, with an average length of about 1 mm. The embryo is enlarged at the proximal end and enclosed within a body of corresponding shape (normally irregularly ovoid as shown in Figure 4A,B,D,F,G). Where seeds are relatively numerous, as is common in *A. fascicularis*, there is a tendency for those that are closely pressed against adjacent seeds to be flattened on their lateral surfaces, making them slightly faceted, although the free surfaces are still rounded. Towards the base of the inner surface there is a small hilum and above this is a slight to very obvious protrusion attached for its full length to the seed body. The inner protrusion increases the width of the distal end of the seed where its embryo and body are narrowest. The testa of the seed body is crustaceous but thin, and has a fairly smooth surface on which a reticulate pattern of cells is visible. The inner protrusion is usually fairly obvious, contrasting in its texture and/or colour from the smooth, uniformly pale or mottled body of the seed. Typical *Astartea* seeds, as described here, occur in well over half of the species. Deviations from these in seed shape, colour and testa thickness are correlated with the habitat or reproductive strategy of the species.

*Thick-coated seeds.* Seeds with an unusually thick testa occur in the *A. aspera* group, which extends into relatively dry habitats. These seeds can be distinguished from those of other members of the genus by their reticulate-pitted (Figure 4A; see also Rye & Trudgen 2008: Figure 3A) or colliculate testa. In most members of this group the testa is uniformly dark red or red-brown and contrasts strikingly with the white or off-white protrusion on the inner surface. Fruits in this species group also tend to have thicker walls than those found in other members of the genus.

*Thin-coated seeds.* Throughout the tribe Chamelaucieae, it is usual for seeds of indehiscent fruits to have a very thin testa, and there may also be a modification of the seed shape and orientation. *Astartea transversa* produces a single, horizontal seed, wrapped around its attachment point (Figure 4I). The shape of the seed in this case is almost reniform but with one end distinctly smaller than the other. In *A. arbuscula* the solitary seed is more erect and closer to the normal shape for *Astartea*, but its testa is membranous.

*Seed colour.* *Astartea* seeds vary from uniformly off-white to golden brown through variegated colouring to uniformly dark red or red-brown (as noted above for some thick-coated seeds). Mottled seeds may show a large degree of infra-specific variation in their markings (Figure 4F,G), often including some obvious variation within each fruit.

*Chaff.* Chaff pieces are often very compressed or shrivelled and uniformly dark-coloured (Figure 4E,H), in striking contrast to the plump seeds (Figure 4D,F,G). In *A. cicatricosa* Rye & Trudgen the chaff pieces (Figure 4C) have a more seed-like appearance, but are colliculate rather than reticulate-pitted and lack the strongly contrasting, whitish inner protrusion found on the seeds (Figure 4B).

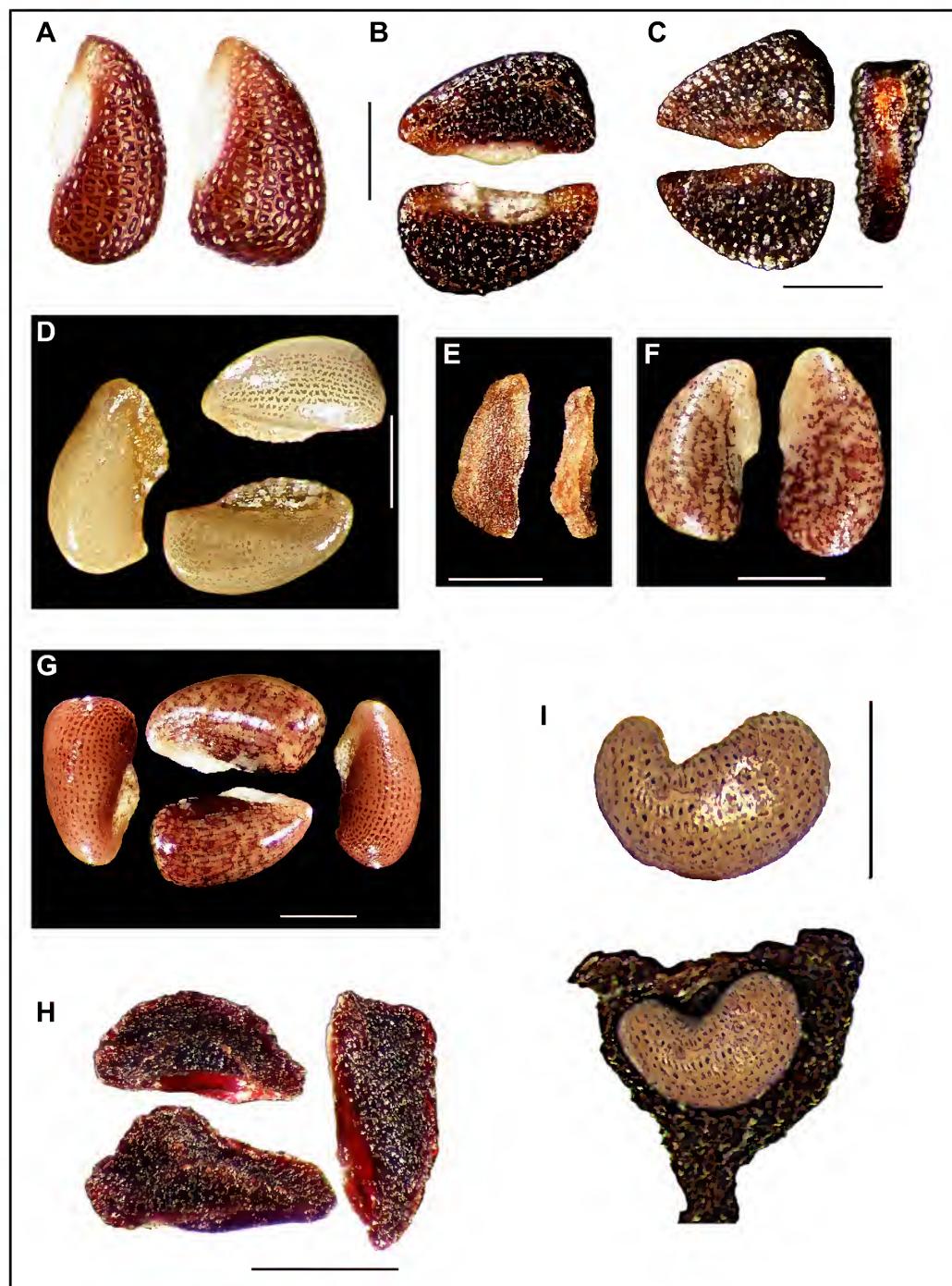


Figure 4. *Astartea* seeds and chaff. A – seeds of *A. aspera*; B – seeds of *A. cicatricosa*; C – chaff of *A. cicatricosa*; D – seeds of *A. granitica*; E – chaff of *A. granitica*; F – seeds of varied size in *A. schaueri*; G – seeds of varied colour in *A. schaueri*; H – chaff of *A. schaueri*; I – seed of *A. transversa*, also shown below still embedded in the indehiscent fruit. Scale bars = 0.5 mm. Images from B.E. Hall 30 A (A); A. Strid 21898 (B, C); A.R. Annels 5645 (D, E); R. Davis 4791 (F, H); R.W. Hearn ARA 5714 (G) and E.A. Griffin 4073 (I). Prepared by A.R. Williams.

## Distribution and phenology

*Astartea* is restricted to the south-west of Western Australia (Figure 5A), with its peak concentration in the region of high rainfall and relatively low temperature along the south coast between Northcliffe and Albany. It extends north to the Moore River, west to Augusta and east to Cape Arid National Park and Middle Island, but only extends as far inland as the Dumbleyung area.

### Habitat

*Astartea* species occur in damp habitats associated with depressions, watercourses and rock formations such as granite outcrops. Most species are predominantly associated with swamps and watercourses, including one (*A. leptophylla* Schauer) that is confined to the banks of seasonally fast-flowing watercourses. Three members of the genus, *A. fascicularis*, *A. granitica* and *A. middletonii*, appear to be restricted to granitic habitats, while *A. montana* and *A. decemcostata* Rye occur in other kinds of rocky habitats in the Stirling and Barren Ranges respectively. The soils of these damp habitats tend to have a high organic content.

The riverine species *A. leptophylla* has all the typical morphological and reproductive traits (listed below) of a rheophyte. Van Steenis (1981: 3) defines rheophytes as plants that are found in ‘the beds of swift-running streams and rivers and grow there up to flood-level, but not beyond the reach of regularly occurring flash floods’. Rheophytes are usually glabrous and are characterised by their anchorage and toughness, establishment from seed, but often also with vegetative reproduction, and their densely arranged, narrow leaves.

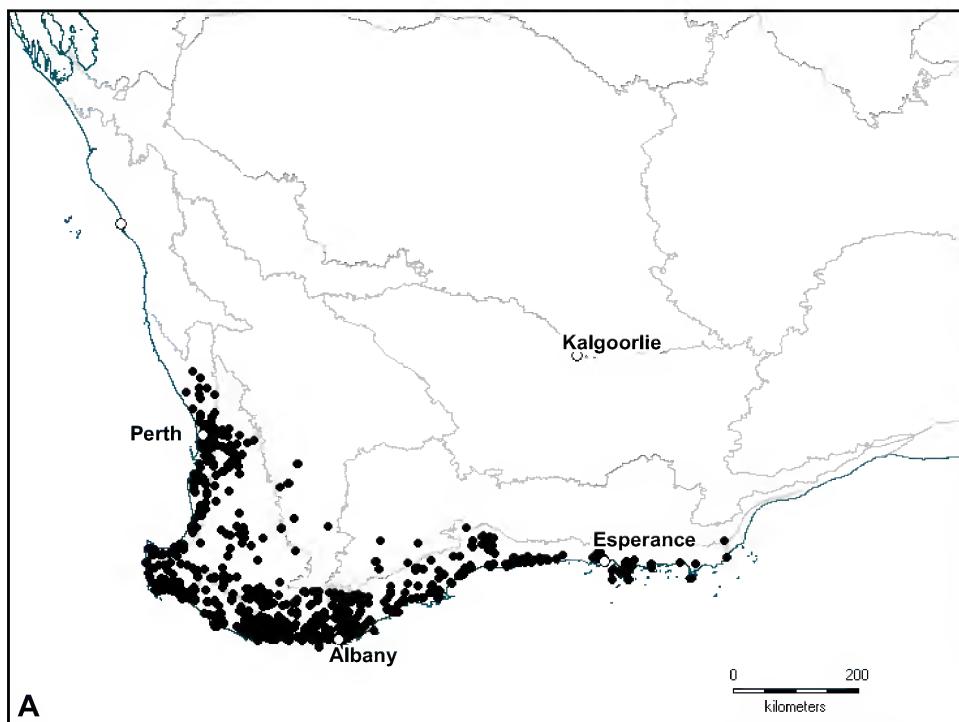
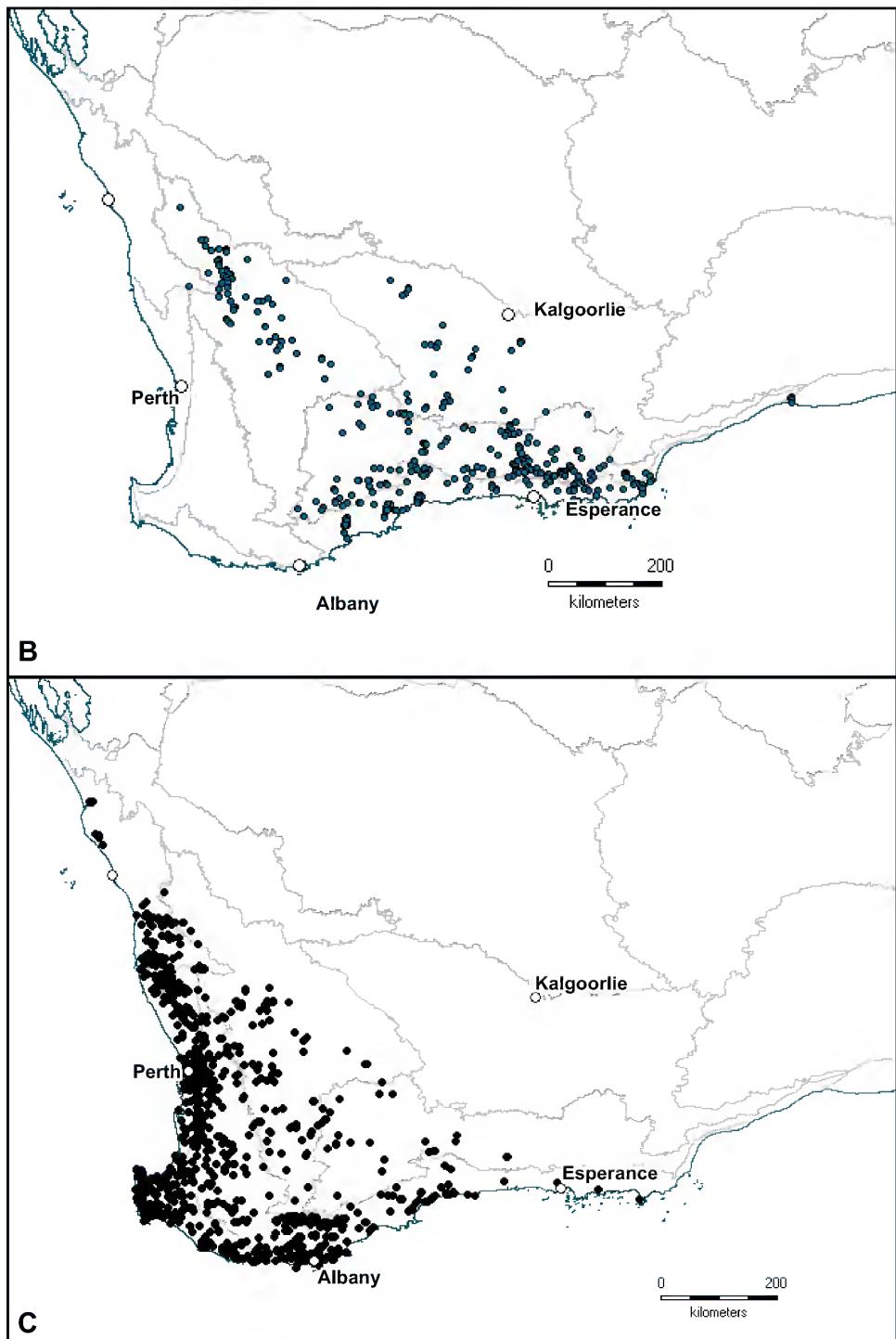


Figure 5. Generic distributions. A – *Astartea* (●); B – *Cyathostemon* (●); C – *Hypocalymma* (●) (facing page).



## Phenology

A possible consequence of the association of *Astartea* species with damp environments is their tendency to flower during the dry season. Most species flower during summer, often peaking in January, although a few flower predominantly in spring and early summer. Fruits are produced quickly following flowering; as flowering usually continues for several weeks, the stems may show a progression from young buds through to fruits (see Figure 2B). In most taxa, capsules remain attached to the plant long after they have shed all or most of their seeds, and a few may still remain on the stems during the following flowering season. Several taxa, however, produce indehiscent fruits, which are shed from the plant together with the enclosed seeds.

## Insect associations

Many insect groups are associated with *Astartea* species, some benefiting the plants and others harmful, the latter kind utilising the sap or organs of the plants for a food source. Beneficial insects include pollinators and the predators or parasites of the harmful insects. As discussed under *Seed adaptations* below, insects might also play a role in seed dispersal. Of greatest interest are those insects that display host-specificity to the genus *Astartea*, or to its generic grouping, or to the tribe Chamaeleuciaeae as a whole.

### Blossom feeders

*Astartea* species are predominantly insect-pollinated. Keighery (1982) considered pollination by native bees to be of greatest importance in *Astartea*, with beetles and flies also contributing. Houston (2000) listed 11 native bee species in five genera as visitors to *Astartea* flowers. Brown *et al.* (1997) listed one jewel beetle, *Themognatha mitchelli*, as a visitor to *Astartea* flowers; jewel beetles were commonly observed in the current study, for example on *A. affinis* (Figure 1B).

Adult males of the wingless fly species *Badisis ambulans*, whose larvae inhabit the pitchers of the Albany Pitcher Plant (*Cephalotus follicularis*), ‘forage on *Astartea fascicularis* (Myrtaceae) blossom during the day’ (Yeates 1992: 423). They mimic a group of ants, belonging to the genus *Iridomyrex*, which are common in the areas where the fly species occurs. Probably the most common insect visitors to the flowers observed in the current study were ants, but whether these or the ant-like flies play any significant role in pollination is unknown. Interestingly, the only species of *Astartea* recorded from the area close to Pemberton where Yeates collected male *Badisis* flies is *A. laricifolia* and its main area of distribution coincides very well with the distribution of *Cephalotus*, raising the possibility that *A. laricifolia* is the primary host species for these adult flies. Certainly *A. fascicularis* s. str. is not a contender as it occurs well outside the geographic range of *Cephalotus*.

As *Astartea* species tend to flower in summer at a time when most other kinds of angiosperms are relatively inactive, they are a major source of nutrition for a wide range of nectar-feeding insects at that time of year. *Astartea laricifolia* is particularly floriferous, and in the early morning its flowers attract a horde of insects of very varied kinds. This may be one reason for a high success rate of pollination in *Astartea* (see below under *Chromosome numbers and breeding systems*).

### Sap Feeders

Most of the insects that feed on plant sap are bugs (order Hemiptera), including the extremely large

family Miridae. The south-western Australian Mirid genus *Myrtlemiris* appears to have most of its species confined to host genera in the tribe Chamaeleuciae (Cheng *et al.* 2012). One species, *M. astartephila*, is currently known from a single *Astartea* host species. More field work is needed to determine the degree of host-specificity of this insect, as most *Myrtlemiris* species have been recorded from more than one host genus within the tribe.

Larvae of Felt Scales (family Eriococcidae) can occur in large numbers on *Astartea* stems. These insects belong to the small genus *Callococcus* (L. Cook pers. comm.), whose type species, *C. pulchellus*, was named from a host species in the related genus *Hypocalymma*. *Callococcus* infests most species of *Astartea*, having been recorded so far in *A. affinis* (F. Hort 3155 & J. Hort), *A. arbuscula* (e.g. A.R. Annels 5295 & R.W. Hearn, N. Gibson & M. Lyons 103), *A. aspera* (e.g. R. Davis 4961), *A. cicatricosa* (e.g. L. Ang & S. Kern 10358), *A. corniculata* Schauer (B.L. Rye 221260), *A. decemcostata* (M. Hislop 2885, S. Barrett & J.A. Cochrane), *A. glomerulosa* (e.g. R.J. Cranfield & B.G. Ward WFM 285), *A. laricifolia* (D. Rooks 124), *A. leptophylla* (e.g. J. Forrest s.n. MEL 76237), *A. montana* (e.g. B.L. Rye 221263), *A. schaeueri* (e.g. B.L. Rye 221246), *A. reticulata* Rye (e.g. G. Craig 8004) and *A. scoparia* (e.g. M.E. Trudgen 20428 & R. Archer).

The *Callococcus* larvae (Figure 6) occur at nodes on the stems, often with several at a single node, and there is a marked difference between the male and female larvae. Females have a shell-like cover that is whitish throughout, although it may become greyish or brownish with age. At maturity, the shell is very thick and appears somewhat crustaceous (Figure 6A). It is usually longitudinally patterned, having two broad, parallel furrows (see right side of Figure 6B). In some cases the shell is shorter and transversely furrowed but whether this represents a different species or infraspecific variant of *Callococcus* is not yet known. Male larvae form smaller, nondescript, felted covers (left side of Figure 6B).

To date no *Callococcus* infestations have been found on any specimens of *A. zephyra*, not even at a locality (B.L. Rye 241204 & 241205, F. Hort & J. Hort) where it occurred intermixed with a highly infested population of *Hypocalymma angustifolium* Endl. (B.L. Rye 241206, F. Hort & J. Hort). This suggests either that *A. zephyra* is not susceptible to *Callococcus* or that the particular species or variant of *Callococcus* present was host-specific to *Hypocalymma*.

Within the tribe Chamaeleuciae, *Astartea*, *Cyathostemon* and *Hypocalymma* are evidently the only host genera for *Callococcus*, based on an extensive survey of PERTH herbarium specimens of all genera of the tribe. *Callococcus* has been found across most of the combined geographic range of these three closely related plant genera (Figure 5) in the south-west of Western Australia and has evidently co-evolved with them. A quite distinct type of *Callococcus*, in which the larvae produce galls rather than scales, occurs on *Leptospermum* Forst. & G. Forst. of the related tribe Leptospermeae DC.

More numerous species of sap-utilising insects have larvae attached to leaves rather than stems. Some species or genera might be specific in their host plants, but a specialised study of each insect group would be needed to investigate this possibility. Several kinds of black scales, probably formed by whitefly larvae (family Aleyrodidae), have been recorded on *Astartea*, for example on *A. corniculata* (e.g. E.J. Croxford 918), *A. muricata* (F. & J. Hort 2497) and *A. scoparia* (R.J. Cranfield 22509). This group of insects appears to include species that are host-specific for certain members of the Chamaeleuciae, but no evidence has been found in the current study to indicate any being host-specific to *Astartea*.

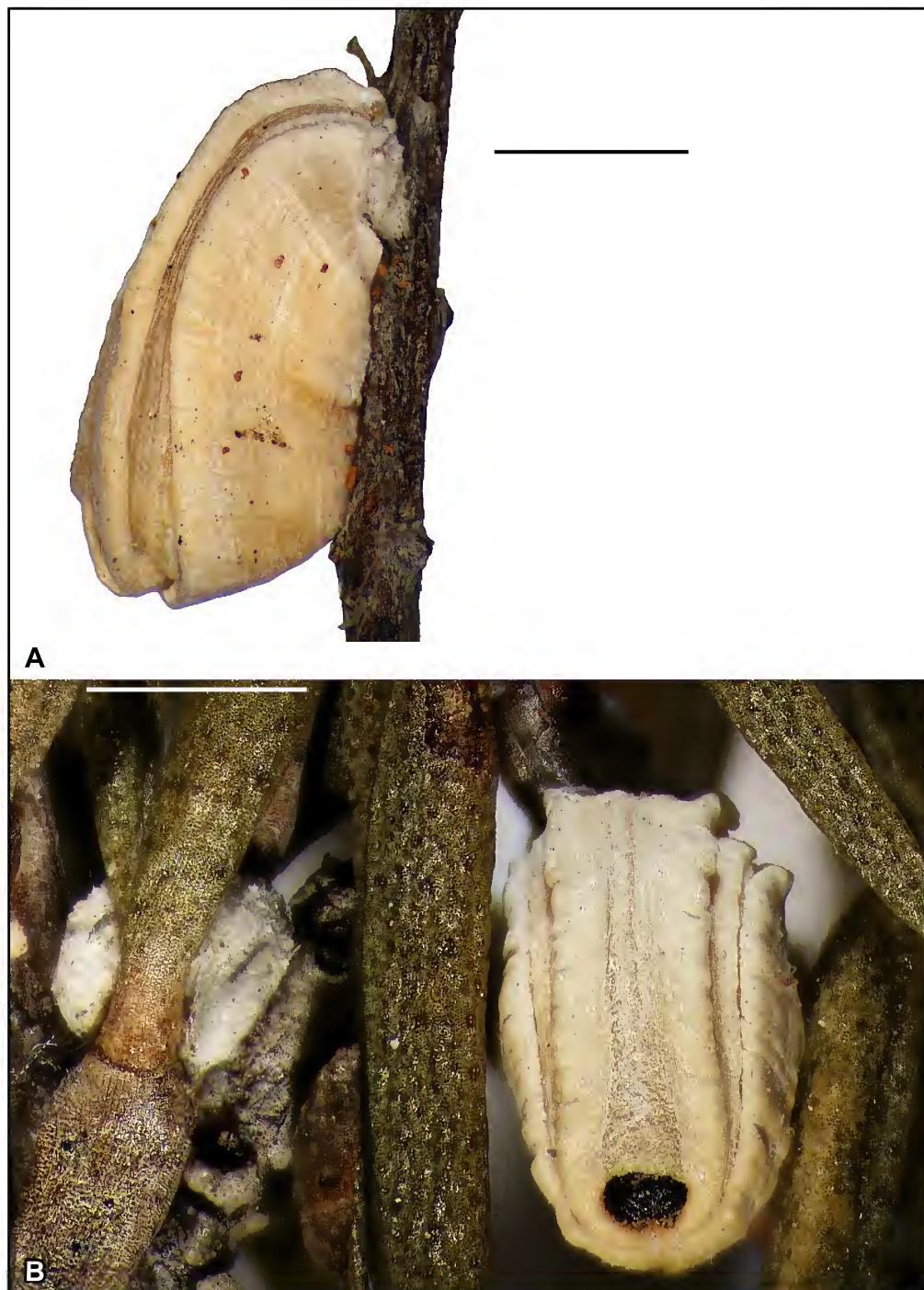


Figure 6. *Callococcus*. A – female scale on *Astartea arbuscula*; B – two male scales (left) and a female scale (right) on *Astartea scoparia*. Scale bars = 1 mm. Images from B.L. Rye 221237 & R.W. Hearn (A) and M.E. Trudgen 20428 & R. Archer (B). Prepared by A.R. Williams.

## Galls

Various kinds of rounded galls, formed from flowers or other organs, have been observed on most species of *Astartea*. Also common are galled young shoots with abnormally broad leaves that are appressed and imbricate (Figure 1F). The insects or other factors responsible for inducing these galls have not been identified, although it is likely that galls commonly contain wasp larvae, as has been established in the genus *Enekbatus* Trudgen & Rye (Trudgen & Rye 2010).

## Other aspects of the biology of *Astartea*

### Growth forms

Most species of *Astartea* produce below-ground lignotubers and have three to numerous main stems separated at ground level. They resprout readily after their aerial parts have been destroyed by fire or other factors (Figure 1A). Lignotubers may also confer some degree of protection against the root-infecting fungus *Phytophthora*, with non-lignotuberous species such as *A. granitica* being more susceptible (R. Hearn pers. comm.). Seedlings in lignotuberous species are often rare, except where disturbance has resulted in open ground, as on road verges.

Obligate-seeder species lack a lignotuber but produce numerous seedlings following the death of the mature plants by fire, drought or other causes. Initially single-stemmed at the base, they may either remain with this habit or produce several lateral main branches just above ground level, and the base may become enlarged. The multi-branched growth form is common in many shrub genera of Myrtaceae, such as *Thryptomene* Endl., and possibly confers greater fire-resistance than that with the single stem continuing for some height above the ground.

Differences in reproductive success have been observed in two gardens at Manjimup (R. Hearn pers. comm.), where the single-stemmed species *A. granitica* produced self-sown seedlings but several lignotuberous species did not. A detailed study of *A. granitica* [as *Astartea* sp.] by Hutchison (1997) has provided evidence that fire assists in breaking seed dormancy, with germination rates of less than 15% increased to over 70% by the application of smoke-treated water.

A third growth form produced by suckering is commonly found in *A. leptophylla* along river banks. The single main stem of this species is commonly rendered more or less horizontal following subsidence of the river bank; from this a row of connected, but individually rooted, erect stems is produced. Suckering is also found in the *A. aspera* group when plants occur on river banks, although in this case forming a lower, more spreading habit. Other species may also be capable of reproducing in this way following various kinds of disturbance, or at least of forming a row of unrooted erect stems along a fallen main stem lying above the ground, as has been observed in *A. laricifolia*. *Astartea laricifolia* may be single- or multi-stemmed, perhaps developing a lignotuber when conditions favour this growth form.

### Infra-specific variation

Some taxa show a remarkable degree of variation within some populations. Characters that vary within populations of *A. laricifolia* include habit (see above) and the degree of development of wings on the young stems. Some *A. affinis* populations show great variation in flower size or the degree of horning on the sepals.

Much of the variation observed within species is seasonal or caused by variation from one year to the next in the amount of rainfall, occurrence of fires, etc. There is also considerable variation within and between populations owing to genetic and microhabitat differences at any given time. All of these sources of variation contribute to the taxonomic difficulty of the genus.

Over summer the plants may be under considerable stress as their winter-wet habitats dry out. An early response to this is the shedding of the lower leaves, which often first turn yellow or red. Failure of seed development, perhaps as a result of excessive water stress in a bad season, was observed in 2003 in a population of the lignotuberous species *A. middletonii*. This species is restricted to granite outcrops, where the effects of drought may be more extreme than for plants occurring along watercourses or associated with other wetlands.

### **Chromosome numbers and breeding systems**

The base chromosome number for the genus is evidently 11, the same as for the family as a whole, although only one species has been sampled so far. That taxon, a member of the *A. aspera* group, was tetraploid, having 22 chromosomes (Rye 1979).

As in many other Myrtaceae, *Astartea* has protandrous flowers, increasing the chances of cross-pollination. Well exposed nectar and pollen attracts a large number of ants, bees, wasps, beetles, flies and other insects to the flowers. The success of this relatively unspecialised pollination strategy is evident from the high proportion of seed set in most cases.

### **Seed adaptations**

Seeds are generally smaller in *Astartea* than in the related genera *Cyathostemon* and *Hypocalymma*, and the seed coat is usually thinner and less crustaceous, although it is quite well developed in the *A. aspera* group. These seed characters are presumably an adaptation to the moist but relatively exposed sites favoured by most species of *Astartea*. The *A. aspera* group, with relatively thick-walled capsules containing relatively large (up to 1.3 mm long) seeds with a thick testa, extends further inland than other species groups, although still restricted to moist habitats within this drier climatic region. The smallest seeds, down to 0.6 or rarely 0.5 mm long, tend to occur in the species occurring in the most humid environments, at least in comparison with their closest relatives.

Hutchison (1997: 36, Figure 9A) was the first to document the existence of a structure, which he described as 'a soft fleshy elaiosome', on the inner surface of *Astartea* seeds. In his study of *A. granitica* [as *Astartea* sp.], Hutchison suggested that the relatively delicate seeds would not survive the extreme summer conditions on a granite outcrop unless taken below ground by ants. The presumed elaiosome, referred to in the morphology section as the 'inner protrusion', is succulent on young seeds and is slightly to markedly different in colour from the remainder of the seed. No studies have been conducted to test the theory that this structure does function as an elaiosome in *Astartea*, but its size and nature in some species such as *A. granitica* suggest that it would be attractive to ants. Similar seed morphology is found in *Cyathostemon* and *Hypocalymma* species, and ants have been observed collecting seeds from two species of the latter genus (G. Keighery pers. comm.).

Being so firmly attached to the seed body, the inner protrusion would not be easy to dislodge, unlike the situation in genera such as *Euryomyrtus* Schauer and *Rinzia* Schauer that have an aril only narrowly attached to the seed body; in the latter genera ants might be able to remove the elaisome from the seed

body *in situ* rather than transporting the entire seed. Clearly, however, the inner protrusion does not always function as an elaiosome as it has been greatly reduced in size in some species of *Astartea*. Evidence that it is linked to seed dispersal in some way is the fact that it is most reduced in *Astartea* species that have indehiscent fruits.

Even when the protrusion is reduced in size, it could provide an easier point for ants to grasp than the smooth testa, so perhaps its function is primarily to improve the portability of the *Astartea* seeds rather than to provide nutrition. While the testa is usually too thin to prevent ants from gaining access to the embryo, the storage of seeds for later consumption in ant nests could have the benefit of preventing other granivores from eating the seeds and improve the likelihood of a few seeds surviving until conditions suit germination.

Among those species of *Astartea* with an indehiscent fruit, there are no obvious structures attached to the fruits that might assist with seed dispersal. However, indehiscent fruits are very small and single-seeded, and are still light enough for ant-dispersal to be a possibility.

### Hybridisation

Many pairs of *Astartea* species have been observed growing in intermixed or adjacent stands in the wild, particularly along the south coast from the Walpole area to the Albany area. A similar situation exists in *Kunzea* Rchb. sect. *Zeanuk* Toelken (tribe Leptospermeae), which is also restricted to the wetter areas of the south-west and thrives in disturbed areas. Toelken (1996) reported that hybridisation was widespread in this group. Additional species were later named to replace some putative hybrids in this taxonomically difficult group (Toelken & Craig 2007), but hybrids are still considered to be present.

In the field, the most obvious differences between co-occurring species of *Astartea* are generally in their mature size and form, such as whether or not they develop a lignotuber, and in their flowering stage. Flower size and colour, leaf size and shape and other characters may also differ significantly between two taxa at the same locality and there are often differences in microhabitats. Co-occurrence of species is mostly observed in swampy locations, with some species occurring in the centre of the swamps and others restricted to somewhat drier microhabitats around the margins. Those from the driest habitats tend to flower earliest, beginning in late spring, while those from the dampest habitats often do not flower until mid-summer. This reduces the opportunities for inter-specific cross-pollination. However, a few apparent cases of hybridisation are noted, and one presumed hybrid is fully described in this paper.

A cultivar known as *Astartea* ‘Winter Pink’ arose in cultivation by selection from hybrid seedlings of the plant with the greatest intensity of pink colour in its flowers (APNI 2013), the parents reputed to be *A. clavulata* Turcz. [= *A. aspera*] and *A. astarteoides* (Benth.) Rye. Although the identities of the parents are far from certain, a combination of one parent from the *A. aspera* species group and one from the *A. montana* group may well have been involved in view of the small size of the plant and its pink flower colour. Both species groups tend to flower primarily in spring rather than summer, a tendency that may have combined to produce an even earlier flowering time in the hybrid. No natural taxa within the genus are known to flower primarily during winter as suggested by the name of this hybrid cultivar.

## Reproduction and conservation

As a general rule *Astartea* species reproduce readily, are abundant at most of their locations and readily colonise road verges and other open ground. Some taxa, however, are at risk because they are geographically restricted. Some populations may be at risk from increasing salinity or weed infestation of their winter-wet habitats, especially in areas surrounded by land cleared for farming or urban developments.

*Astartea* species are easy to propagate by seed or cuttings, and thrive under cultivation in south-western Australia, requiring no watering when grown in the more humid areas of the region. They may tend to have greater shoot: root ratios than most species from similar habitats. In a study of swamp communities near Gnangara, Dodd *et al.* (1984) noted that '*Astartea fascicularis*' [probably actually *A. scoparia*] had a root: shoot ratio in excess of 1 and was able to resprout from its root stock, whereas most species (from other genera) with a similar type of rooting pattern had a much lower root: shoot ratio and were much more susceptible to fires.

This ease of reproduction seems appropriate in a genus named after a goddess of fertility, and gives *Astartea* species the potential to become weeds. A few taxa have been recorded as starting to naturalise in south-eastern Australia (Richardson *et al.* 2006) or as having escaped from cultivation in New Zealand (de Lange *et al.* 2005).

## Generic affinities and delimitation

As explained in the introduction, the delimitation of *Astartea* accepted here is that used in early publications from De Candolle (1828) to Turczaninow (1852). Later, beginning with Mueller's (1859, 1860) papers, the delimitation of the genus was confused both by the inclusion of atypical species and by the exclusion of species with very low stamen numbers. Most of the atypical species, including six that are currently known by informal names under *Astartea* on FloraBase (Western Australian Herbarium 1998–), are now considered to belong to the genus *Cyathostemon*, and two other species belong to *Seorsus*.

The newly segregated genus *Seorsus* has a very different distribution pattern (Rye & Trudgen 2008: Figure 4) from *Astartea* and differs in many morphological characters, particularly in its more faceted seeds and distinctive anther morphology (see Rye & Trudgen 2008 for a full discussion of the degree of their relationship and the similarities and differences between the two genera).

## Evidence for affinities between *Astartea*, *Cyathostemon* and *Hypocalymma*

A strongly supported clade comprising *Astartea*, *Cyathostemon* and *Hypocalymma* has been obtained in molecular studies (Lam *et al.* 2002; Wilson *et al.* 2004) using four regions of chloroplast DNA (the *matK* gene, the 5' *trnK* intron, part of the *ndhF* gene and the *atpB-rbcL* intergenic spacer). The clade is also strongly supported in molecular analyses using the ETS nuclear ribosomal region (Wilson & Heslewood 2011; P. Wilson unpublished data).

As noted in the *Insect associations* section above, *Astartea*, *Cyathostemon* and *Hypocalymma* are host plants for *Callococcus*, an insect genus that is not known to infest any other members of the tribe Chamaeleuciaeae, providing further evidence for the monophyly of the group.

Morphological similarities in the androecium and seeds indicate a very close relationship between *Astartea*, *Cyathostemon* and *Hypocalymma*. All genera have a variable number of stamens per flower, with the filaments variously united to some degree at the base into a ring or into fascicles; the only exception to this is seen in species of *Astartea* where the stamens are so reduced in number in that they are all free, but this is clearly a derived character (apomorphy). The three genera have more or less basifixated anthers with longitudinally dehiscent cells and a free connective gland. Their seeds are hard-coated, with little or no faceting, and they have a protrusion that is united for its whole length and width to the inner surface of the seed body.

As the three independent kinds of evidence, obtained from studies of morphology, molecular sequences and insect associations, concur, it can be concluded that the three genera *Astartea*, *Cyathostemon* and *Hypocalymma* form a monophyletic group.

### **Distinction of *Astartea***

Significant differences between *Astartea*, *Cyathostemon* and *Hypocalymma* in their morphology, chemistry and habitat preferences support the recognition of all three genera.

**Stamens.** Except for those taxa with very reduced stamen numbers, members of the genus *Astartea* s. str. have rarely been confused with the many genera that have been included in Bentham's (1867) very broad circumscription of *Baeckea*. This is because the arrangement of the stamens into fascicles opposite the sepals is a readily observable characteristic that is rare elsewhere in the family. A diagram of stamen arrangements in the Myrtaceae given by Johnson and Briggs (1984: Figure 8) includes one part (K) intended to represent the situation in *Astartea*, but is inaccurate in showing the longest stamens central rather than marginal (see Figure 3F). In genera with stamen fascicles opposite the petals, such as *Melaleuca*, the longest stamens do occur at the centre of the fascicle. This difference in the shape of antisepalous and antipetalous fascicles reflects a general tendency in Chamelaucieae, and in the family as a whole, for the longest stamens to be opposite the petals and the shortest ones opposite the sepals.

*Hypocalymma* species usually have numerous stamens united into a continuous ring, although very shallowly united fascicles occur in *H. scariosum* Schauer when its stamen numbers are low (12–15 per flower). *Cyathostemon* species never have discrete antisepalous fascicles, as in every case their stamens are all united into a complete ring. However, the stamens sometimes tend to form antisepalous groups, with the ring more deeply cut opposite the petals than elsewhere, as in *C. heterantherus*. In other species of *Cyathostemon*, such as *C. blackettii* (F.Muell.) Rye & Trudgen, the ring is either more irregular in shape or of more uniform depth throughout. Although *Astartea* has varied arrangements of its stamens (see Morphology section), all of them differ from the arrangements found in *Hypocalymma* and *Cyathostemon*. Even in the rare instances when its stamens are united into a complete circle, as sometimes occurs in *A. montana* and rarely in other species, the presence of antisepalous fascicles alternating with solitary antipetalous stamens is unlike anything found in the other two genera.

**Seeds.** *Astartea* seeds are smaller than those in *Cyathostemon* and most species of *Hypocalymma*. The seed testa in most species of *Astartea* is thin, with a finely reticulate, smooth surface rather than boldly reticulate-pitted as in *Hypocalymma* sect. *Hypocalymma* or smooth (but not so reticulate) to colliculate in *Cyathostemon* and *Hypocalymma* sect. *Cardiomyrta* Schauer. An exception to this difference is the *A. aspera* group, which has a thicker testa, usually with a reticulate-pitted pattern more like that found in *Hypocalymma* sect. *Hypocalymma*, but the latter group has larger seeds with usually much deeper pits in the testa.

*Other morphological differences.* Some further morphological differences between the three genera are given in Rye and Trudgen (2008: Table 1) and the key on page 248 of that paper.

*Distribution and phenology.* All three genera occur only in south-western Australia (Figure 5), but unlike *Astartea*, *Cyathostemon* and *Hypocalymma* are not restricted to damp habitats; *Hypocalymma* extends much further north while *Cyathostemon* extends much further inland. *Astartea* is almost fully contained within the distribution of *Hypocalymma* but has a very different distribution pattern from that of *Cyathostemon*, overlapping only in the eastern part of its range from the Stirling Range area eastwards. Whereas most *Astartea* species flower in summer, most *Cyathostemon* and *Hypocalymma* species, even those associated with damp habitats within the range of *Astartea*, flower in spring.

*DNA.* In the molecular studies cited earlier, *Astartea s. str.* always had a very high degree of support as a monophyletic group. Although the chloroplast regions did not provide support for the recognition of the other two genera as they are currently defined, there was some support for all three genera in unpublished data for the ETS nuclear ribosomal region. If a broad circumscription of *Astartea* were to be adopted in the future, it would need to include both *Hypocalymma* and *Cyathostemon*, not just the latter as it has in the past.

*Essential oils.* In extracts taken from the leaves and terminal stems of two species of *Astartea*, Lowe *et al.* (2005) obtained high yields of essential oils, the three substances with the greatest concentrations being a-pinene, linalool and myrtenal. Lowe *et al.* suggested that the genus could prove useful as a commercial source of myrtenal, a substance known to repel aphids, weevils and ticks. The makeup of essential oils produced by the other two genera has not been documented; however, *Astartea* species are distinguishable from *Hypocalymma* species by the odour produced when their leaves are crushed (E. Middleton pers. comm.).

### Species groups based primarily on seed and sepal morphology

The following morphological groups may assist in the identification of *Astartea* species, although they do not necessarily reflect relationships.

#### 1. *Astartea aspera* group

Seeds with a thick, reticulate-pitted or colliculate testa. Sepals smooth to very shortly horned. (Two species of the first subgroup have muricate stems.)

- a. Seeds uniformly red

- A. aspera*
- A. cicatricosa*
- A. muricata*

- b. Seeds partly red

- A. decemcostata*
- A. reticulata*

#### 2. *Astartea montana* group

Seeds with a thin, mottled, smooth testa. (Three species of the first subgroup have the hypanthium reticulate-pitted.)

- a. Sepals not or scarcely horned

- A. astarteoides*
- A. glomerulosa*
- A. montana*
- A. transversa*

**b.** Sepals horned

- A. corniculata*
- A. middletonii*
- A. schaueri*

**3. *Astartea scoparia* group**

Seeds with a thin, whitish to medium brown, smooth testa.

**a.** Sepals not horned

- A. arbuscula*
- A. fascicularis*
- A. laricifolia*
- A. leptophylla*
- A. scoparia*
- A. zephyra*

**b.** Sepals horned

- A. affinis*
- A. eobalta*
- A. granitica*
- A. onycis*

### Generic description

***Astartea*** DC., *Prod.* 3: 210 (1828). *Baeckea* sect. *Astartea* (DC.) Nied. in A. Engler & K. Prantl, *Nat. Pflanzenfam.* III, 7: 99 (1893). Type: *Astartea fascicularis* (Labill.) DC.

Dwarf to tall *shrubs* or small *trees*, glabrous, many species with a lignotuber. *Leaves* opposite and decussate (very rarely in alternating whorls of three), spreading, often in fascicles on very short lateral branchlets, small, entire, very shortly petiolate, the petiole often poorly defined; blade in most leaves oblong to linear or narrowly obovate from top view and slightly broader and often more obovate from side view, usually with the abaxial surface very deeply convex and the adaxial surface flat or shallowly concave and often with a midline groove, rarely almost terete, dotted with rather inconspicuous to prominent oil glands. *Inflorescence* of solitary, axillary flowers (except in *A. muricata*, which has up to 3 flowers per peduncle and occasionally has two peduncles per axil) in one to many decussate pairs, the pairs widely spaced to rather densely clustered. *Peduncles* straight or somewhat recurved, with two bracteoles at the summit. *Bracteoles* enclosing the bud at first, usually caducous or deciduous but sometimes persistent at anthesis, often slender from side view but broader and more deeply hooded if continuing to enclose the bud as it enlarges, with a herbaceous keel and scarious margins, the margins incurved and the adaxial surface concave, often with a subterminal dorsal point. *Pedicels* usually present, much shorter than to somewhat exceeding the peduncles. *Flowers* predominantly 5-merous, occasionally 4- or 6-merous, protandrous. *Hypanthium* usually obconic to cup-shaped or broadly so, rarely somewhat compressed, often with 5 poorly defined longitudinal ribs opposite the sepals and sometimes also smaller ribs opposite the petals; adnate portion usually green, gland-dotted and

sometimes irregularly rugose-pitted; free portion much shorter than adnate portion, tending to become reddish. *Sepals* usually 5, fairly erect in flower, persistent in fruit, depressed-ovate to semicircular or subtriangular (not including the horn when present), with a herbaceous keel and a more scarious margin; keel incurved, often ridged, sometimes produced into a subterminal, dorsal horn. *Petals* usually 5, widely spreading in flower, deciduous in fruit, broadly obovate to circular, shortly clawed at base, white or pale pink to very deep pink. *Antipetalous processes* variable in number, mostly finger-like, minute. *Androecium* of 3–60 stamens and 0–10 staminodes, all or mostly antisepalous and often in fascicles; fascicles of up to 13 stamens, sometimes with peripheral staminodes, the peripheral filaments longest; antipetalous stamens or staminodes (when present) solitary, often longer than all the antisepalous filaments. *Stamens* shorter than the petals; filament tapering from the base to a slender apex, curved inwards, exceeded by the stigma when the style is mature; anther very broadly to depressed oblong-elliptic in outline; cells parallel and introrse at first but often becoming almost latrorse, longitudinally dehiscent; connective gland small, ± globular. *Staminodes* (when present) either at margins of the antisepalous fascicles or opposite the petals, usually consisting just of the filament and tapering at apex to a point but sometimes terminating in a club-like reduced anther, often distinctly longer than the stamens. *Ovary* usually 2- or 3-locular but sometimes functionally 1-locular; summit dotted with oil-glands, often green at first, becoming dark red; placentas axile, much reduced when ovules very few, otherwise moderately large, ± sessile; ovules 1–23 per loculus, usually variable in number between loculi, when numerous arranged in two close rows along the length of the placenta and with ovules radiating at each end of the placenta. *Style* persistent in fruit, terete, the base inserted in a cylindrical cavity; stigma peltate, ± circular but often slightly 3-lobed from top view. *Fruits* in most species dehiscent by 2 or 3 valves, c. half-inferior and ± circular from top view (but in a few taxa indehiscent, functionally 1-locular, largely inferior and tending to be somewhat compressed or lop-sided), 0.6–3 mm long, somewhat succulent at first, becoming more crustaceous, 1-many-seeded; hypanthium shallowly hemispheric to broadly lobed; summit broad, with top of each loculus raised, convex to acutely angled; inner wall often thin and with a reticulate pattern of cells, sometimes thick and with a bubbly appearance; placentas with usually obvious, small, whitish, raised attachment points for the seeds. *Seeds* 1-many per cell, with the body usually tapering from a broad base, narrowest above the hilum, (0.5–)0.6–1.3 mm long, with outer surface rounded, if numerous then sometimes with the lateral surfaces somewhat flattened; testa with a fine reticulate pattern of numerous rows of minute cells, smooth, shallowly pitted (a pit corresponding to each reticulation) or colliculate, cream to golden brown or red-mottled to uniformly deep red-brown, shiny; hilum small, directly below a fairly inconspicuous to prominent protrusion on inner surface; inner protrusion succulent when young, white to reddish, usually somewhat to very differently coloured from the remainder of the seed. *Chaff pieces* usually irregularly shrunken, rarely seed-like, often brown to dark reddish.

*Etymology.* Named after the Semitic goddess of love and fertility, Astarte, for whom the myrtles were sacred.

*Common names.* No common names have been used for members of this genus except for one species that was given an inappropriate common name because it was previously considered to be a *Baeckea* species. New common names are coined here for some of the species.

#### Key to the species and subspecies of *Astartea*

Important differences between *Astartea* species include habit (e.g. whether lignotuberous), mature seed characters and habitat, all of which are not always apparent from herbarium material. A more flexible means of identifying *Astartea* species, currently available at PERTH, is an interactive key to the entire tribe (Rye *et al.* 2011–).

1. Ovary functionally 1-locular or 2-locular in most or all flowers; ovules 1–10 in one loculus but often absent or few in the other loculus. Fruits indehiscent or dehiscent, when 1-locular the style base off-centre and only shortly inset
  2. Flowers 1.5–2.5 mm diam. Stamens 3–5, not in fascicles. Ovary functionally 1-locular, with 1 or rarely 2 ovules
    3. Leaves mostly not in fascicles, always opposite, 2.5–5 mm long. Fruits with the hypanthium somewhat compressed bilaterally; seed obliquely positioned, ± broadly ovoid, off-white to golden brown  
(Lake Jasper–Albany)..... ***A. arbuscula***
    - 3: Leaves mostly in dense fascicles, sometimes in whorls of three, 2–2.5 mm long. Fruits not compressed; seed transverse, ± reniform, with reddish markings (Millbrook area)..... ***A. transversa***
  - 2: Flowers 3.5–6.5 mm diam. Stamens usually more than 5, often in antisepalous fascicles. Ovary functionally 1- or 2-locular, usually with several ovules per loculus
    4. Ovary functionally 2-locular, with 2–10 ovules per loculus. Fruits usually dehiscent
      5. Leaves mostly in fascicles, 2.5–4.5 mm long. Outer sepals with a prominent dorsal horn 0.4–1 mm long (Walpole–east of Albany)..... ***A. corniculata***
      - 5: Leaves mostly not in fascicles, 4–10 mm long. Outer sepals smooth to strongly ridged (Brookton Highway–Donnelly River–Scott River)..... ***A. zephyra***
    - 4: Ovary functionally 1-locular, with 1–6 ovules. Fruits (where known) indehiscent
      6. Petals deep pink. Stamen filaments 0.5–0.6 mm long.  
Style 0.6–0.8 mm long (Denmark area)..... ***A. arbuscula* × *corniculata***
      - 6: Petals white or pale pink. Stamen filaments 0.6–1.1 mm long.  
Style 1.2–1.6 mm long  
(Brookton Highway–Donnelly River–Scott River)..... ***A. zephyra***
  - 1: Ovary 3-locular in most flowers; ovules 3–23 per loculus. Fruits dehiscent by valves; style base immersed to the level of the placentas in a long central depression
    7. Mature seeds with a thick, shallowly reticulate-pitted or colliculate testa, usually uniformly dark red-brown and strongly contrasting with the white inner protrusion (but with chaff pieces often lacking the colour contrast) or with a reticulate red pattern rather than a uniform one.  
(Two species that key here can be distinguished by having young stems with crown-shaped outgrowths)
      8. Plants either with crown-shaped outgrowths on the young stems or with smooth sepals. Seeds uniformly dark red or red-brown at maturity
        9. Young stems fairly smooth. Stamens 40–53, in fascicles of 5–11 opposite each sepal and usually also with a single stamen opposite all or some of the petals. Outer sepals not ridged  
(Upper Jerdacuttup River–Hopetoun–Darkanuttup)..... ***A. cicatricosa***
        - 9: Young stems with crown-shaped outgrowths. Stamens 15–35, with 1–11 opposite each sepal and rarely any opposite petals.  
Outer sepals usually ridged

- 10.** Petioles 0–0.5 mm long. Peduncles sometimes paired in the axils, much longer than the pedicels at all stages, up to 3-flowered. Ovules 10–16 per loculus. Occurring well inland (Hotham and Avon Rivers–Dumbleyung area) ..... **A. muricata**
- 10:** Petioles 0.5–0.8 mm long. Peduncles always solitary, much shorter than to much longer than the pedicels in late flower and in fruit, always 1-flowered. Ovules 6–12(–14) per loculus. Occurring on or near the south coast
- 11.** Young stems with numerous, rather crowded, crown-shaped outgrowths. Peduncles 1–2.5 mm long, often shorter or not much longer than the mature pedicels (South Stirling area–Fitzgerald River NP)..... **A. aspera** subsp. **aspera**
- 11:** Young stems with crown-shaped outgrowths few to numerous, sometimes barely developed. Peduncles 2.5–5 mm long, longer (usually much longer) than the mature pedicels (Fitzgerald River–Lort River)..... **A. aspera** subsp. **riparia**
- 8:** Plants lacking crown-shaped outgrowths, the sepals strongly ridged or horned. Seeds partially dark red at maturity
- 12.** Petioles 1–1.5 mm long. Hypanthium rather strongly 10-ribbed. Occurring in gullies on quartzite (Mt Barren Ranges) ..... **A. decemcostata**
- 12:** Petioles 0.4–0.8 mm long. Hypanthium not ribbed or somewhat 5-ribbed. Occurring in swamps or along creek lines (Fitzgerald River NP–Esperance) ..... **A. reticulata**
- 7:** Mature seeds with a thin, uniformly cream to medium brown or red-mottled testa with a smooth, reticulate pattern on the surface (i.e. cells level rather than being pitted or convex)
- 13.** Young stems prominently winged; wings distinctly expanded at the apex. Pedicels usually much longer than the peduncles. Occurring in very damp habitats, often in gullies (Preston River–Augusta–Cape Riche)..... **A. laricifolia**
- 13:** Young stems not winged to moderately winged; wings (when present) fairly uniformly expanded. Pedicels usually shorter than, or similar in length to, the peduncles. Occurring in varied damp habitats including granite outcrops, swamps and river banks
- 14.** Hypanthium (of old buds and young flowers) deeply reticulate-pitted. Petals usually pale to medium pink
- 15.** Shrubs with a lignotuber. Staminodes often present on margins of fascicles or opposite petals. Occurring mainly on and between peaks in a mountain range (Stirling Range area) ..... **A. montana**
- 15:** Single-stemmed shrubs. Staminodes absent. Occurring on the margins of swamps
- 16.** Peduncles 2–4 mm long. Stamens 5–11, with 0–3 per sepal, mostly not in fascicles. Occurring east of Hopetoun (Esperance–Cape Arid NP)..... **A. astarteoides**
- 16:** Peduncles (2–)4–10 mm long. Stamens usually 15–21, with 1–6 per sepal, all or mostly in fascicles. Occurring west of Hopetoun (Donnelly River–east of Albany) ..... **A. glomerulosa**

- 14:** Hypanthium (of old buds and young flowers) smooth or somewhat rugose or with oil glands prominent, but not very pitted.  
Petals usually white or pale pink
- 17.** Plants restricted to granite outcrops or coastal granite.  
Flowers 8–15 mm diam. Stamens 5–13 per fascicle, flanked by staminodes in one species, the other two species with long-horned sepals
- 18.** Young stems with prominently thickened, pale pale grey stripes below each petiole and alternating with reddish brown stripes.  
Sepals prominently ridged, not horned. Stamen fascicles flanked by 1 or 2 long staminodes. Ovules 14–23 per loculus. Occurring on coastal granite (Recherche Archipelago and adjacent coast).....***A. fascicularis***
- 18:** Young stems with thinner, more irregular, pale grey stripes.  
Sepals long-horned. Stamen fascicles mostly without any staminodes. Ovules 10–15 per loculus. Occurring in soil pockets on granite outcrops
- 19.** Single-stemmed shrubs, killed by fires. Mature seeds produced copiously, uniformly coloured (Granite outcrops north of Walpole) .....***A. granitica***
- 19:** Lignotuberous shrubs, resprouting after fires. Mature seeds apparently rarely produced, partially red  
(Granite outcrops north of Broke Inlet).....***A. middletonii***
- 17:** Plants associated with watercourses and runoff areas from rocks and swamps. Flowers 4–11 mm diam. Stamens 0–11 opposite each stamen, if sepals long-horned then some fascicles absent or with less than 5 stamens
- 20.** Seeds developing reddish markings. (Sepals prominently horned in both species)
- 21.** Shrub 0.5–2 m high. Peduncles 4–7 mm long. Flowers 8–11 mm diam. (Broke Inlet–Denmark area) .....***A. schaueri***
- 21:** Shrub usually 0.3–0.5 m high. Peduncles 1.5–3.5 mm long.  
Flowers 4–6.5 mm diam. (Walpole–east of Albany).....***A. corniculata***
- 20:** Seeds uniformly off-white to golden brown
- 22.** Tall shrub or small tree to 5 m high, single-stemmed or with a row of stems through layering (usually with particularly slender leaves). Restricted to river banks subject to destructive flooding (Helena River–Hay River) .....***A. leptophylla***
- 22:** Small to tall shrubs 0.3–3 m high, lignotuberous or single-stemmed, not layering. Associated with swamps or other wetlands, not on major river banks
- 23.** Shrubs single-stemmed or multi-branched at the base, not lignotuberous
- 24.** Outer sepals strongly ridged or shortly horned; horn up to 0.4 mm long. Stamens 21–31, all in antisepalous fascicles of 3–8.  
Ovules 7–14 per loculus (Cape le Grand NP–Cape Arid NP).....***A. eobalta***
- 24:** Outer sepals prominently horned; horn 0.9–1.4 mm long.  
Stamens 6–18, some (rarely all) in antisepalous fascicles of 2–5, usually with solitary stamens or no stamens opposite at least one of the sepals. Ovules 3–9 per loculus  
(Scott River area–D’Entrecasteaux NP).....***A. onycis***

- 23:** Lignotuberous shrubs, resprouting by multiple close basal shoots
- 25:** Young stems usually with a delicate-looking, grey epidermis dotted with small dark glands, with leaves mostly in fascicles.  
Outer sepals smooth to strongly ridged, not horned  
(Moore River–Albany).....**A. scoparia**
- 25:** Young stems not as above, the leaves mostly not in fascicles.  
Outer sepals with a horn 0.3–1 mm long (Gingin–Augusta area).....**A. affinis**

### Species descriptions

**Astartea affinis** (Endl.) Rye, *Nuytsia* 16: 150 (2006). *Baeckea affinis* Endl. in S.L. Endlicher, E. Fenzl & G. Bentham, *Enum. Pl.* 51 (1837). *Astartea endlicheriana* Schauer nom. illeg., *Linnæa* 17: 242 (1843). *Type*: ‘King George Sound’ [actually probably collected near Perth, Western Australia, November–December 1833], *C.A. von Hügel s.n. (lecto: W n.v., photograph seen, left specimen on sheet, *fide* B.L. Rye, *Nuytsia* 16: 150 (2006); possible *isolecto*: central and right specimens on the sheet bearing the lectotype (W n.v., photograph seen)].*

*Astartea* sp. Brixton Rd (G.J. Keighery 5389), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

*Astartea* sp. Waroona (R.J. Cranfield 11429), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

*Illustration*. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002) [as *Astartea* sp. Brixton Rd (G.J. Keighery 5389)].

Erect slender shrub, 1–2 m tall at maturity, multi-stemmed from a lignotuber, with slender stems and relatively long branchlets, the flowering stems erect to spreading or sometimes weeping; young (actively growing) stems somewhat 4-ridged, not or scarcely winged, reddish; older stems pale grey. Leaves widely spaced on the rapidly growing shoots, sometimes in fascicles lower down but mostly not fasciculate, antrorse to widely spreading, fairly straight. Petioles 0.5–1.1 mm long, poorly defined and often appearing to be absent. Leafblades very narrowly obovate to linear from side view, 5–15(–20) mm long, 0.3–0.6(–1.1) mm wide, 0.6–1.1 mm thick, sometimes mucronate. Inflorescence of 2–12(–20) pairs of flowers spread along each branchlet. Peduncles 1–4 mm long. Bracteoles 1.5–3.5 mm long, 0.4–0.7(–1.1) mm wide, acuminate, hooded, with a subterminal point 0.1–0.6 mm long. Pedicels 0.6–2 mm long. Buds 5-horned. Flowers 5.5–8.5(–11) mm diam. Hypanthium 1.5–3(–3.5) mm long, 2–2.5(–3) mm wide; adnate portion dotted with numerous small oil glands, not obviously pitted; free portion 0.4–0.7 mm long. Outer sepals 0.4–1 mm long excluding and 0.5–1.2 mm long including the horn, 1.1–1.7 mm wide, slightly to prominently horned; scarious margin narrow; horn 0.3–1 mm long. Petals 1.8–3(–3.5) mm long, white or pale pink; margin entire or irregularly denticulate. Androecium of 14–28(–42) stamens, in fascicles of 2–7(–10) opposite all or most sepals, sometimes with a solitary stamen opposite one sepal; filaments connate for up to 0.6 mm, the longest 1–1.5 mm long; anthers 0.25–0.3 mm long; staminodes absent or rare. Ovary 3-locular; ovules 5–12 per loculus. Style 1.4–2.3 mm long, the basal c. 0.4 mm immersed; stigma up to 0.35 mm wide. Fruits 3-valvate, usually 2–2.3 mm long, 2–3 mm diam.; hypanthium somewhat 3-lobed, fairly smooth; undeveloped ovules/seeds dark red-brown. Seeds commonly 1–3 per loculus, 0.7–1.3 mm long, 0.4–0.6 mm thick; testa thin, pale golden brown, reticulate-patterned, smooth. (Figure 1B)

**Diagnostic features.** Lignotuberous shrub associated with winter-wet depressions. Flowers 5.5–11 mm diam. Sepals horned. Petals 1.8–3.5 mm long, white or pale pink. Stamens 14–28(–42). Staminodes usually absent. Ovary 3-locular; ovules 5–12 per loculus. Seeds with a thin testa, uniformly coloured, smooth.

**Selected specimens examined.** WESTERN AUSTRALIA: ‘ex horto bot. Petropolitano’, *anon. s.n.* (K); Yallingup, Dec. 1930, *W.E. Blackall s.n.* (PERTH); Twin Swamp Wildlife Sanctuary, Reserve A27621 in the Ellensbrook to Bullsbrook area, 28 Dec. 1971, *N.T. Burbidge 7949* (PERTH); 2.8 km [actually more] N of Waroona, rail/road reserve, 29 Oct. 1997, *R.J. Cranfield 11429* (PERTH); Bowelling–Duranillin road, between Trigwell Bridge Rd and Wunnenberg Rd, SW of Bowelling, 27 Nov. 1994, *V. Crowley DKN 426* (PERTH); Picton Junction, Nov. 1900, *F.L.E. Diels & E.G. Pritzel s.n.* (PERTH); Brixton Rd, Beckenham, Perth, 19 Nov. 1982, *G.J. Keighery 5389* (CANB, PERTH); 1 km N of Serpentine, 13 Nov. 1983, *G.J. Keighery 6563* (PERTH); Chester Forest Block, between Augusta and Nannup, 31 Dec. 1990, *G.J. Keighery 13463* (PERTH); lower Canning River, 2 Jan. 1899, *R. Helms s.n.* (PERTH); Pinjarrah [Pinjarra], 3 Dec. 1877, *F. Mueller s.n.* (MEL 75995); Preston River, 8 Dec. 1877, *F. Mueller s.n.* (MEL 76007); Wellington district, Dec. 1900, *E. Pritzel 87* (AD); 10 m S of creek, 2 km N of Gracetown, 1.5 km NW of Margaret River, 3 Nov. 2006, *D. Rooks 222* (PERTH); Moolabeanee, E of Gingin, 15 Dec. 1953, *R.D. Royce 4745* (PERTH); W side of South Western Hwy, 0.3 km N of Wealand Rd, N of Waroona, 1 Dec. 2002, *B.L. Rye 221202* (CANB, PERTH); Waterloo, 20 Dec. 1984, *Paul G. Wilson 12148* (CANB, PERTH).

**Distribution and habitat.** Occurs mainly close to the west coast from near Gingin south to the Yallingup–Augusta area, also extending inland to near Bowelling (Figure 7A). *Astartea affinis* is found mainly in winter-wet depressions that have a clay layer below the more sandy topsoil, commonly with *Melaleuca* species over sedges and other wetland plants.

**Phenology.** Flowering is mainly in autumn and early summer, from late October to early January, but there are spasmodic records through to mid-April.

**Common name.** West-coast Astartea.

**Conservation status.** This species has numerous populations spread over a relatively large range and is not considered to be at risk.

**Etymology.** From the Latin *affinis* (related to), as Endlicher (in Endlicher *et al.* 1837) believed the species was closely related to the eastern Australian species *Baeckea linifolia* Rudge. However, any similarity between the two taxa is superficial and they show many significant differences.

**Affinities.** Shows a number of similarities to *A. onycis* Rye & Trudgen, differing as discussed under that species. *Astartea affinis* tends to have its leaves more uniformly spaced (i.e. with less tendency for them to be in fascicles) than in the two main species found within its range, *A. scoparia* and *A. leptophylla*, also differing from both of those species by the presence of a short or long horn on its sepals.

**Co-occurring taxa.** *Astartea affinis* overlaps considerably in its distribution with *A. leptophylla*, *A. scoparia* and *A. zephyra*, and to a lesser extent with a number of other species, the most common species within its range being *A. scoparia*. Habitat differences tend to keep *A. affinis* and *A. scoparia* separated, as the former is more commonly found in soils with a layer of clay whereas the latter is often found in soils with a greater sand content. However, *A. scoparia* seems more versatile in its

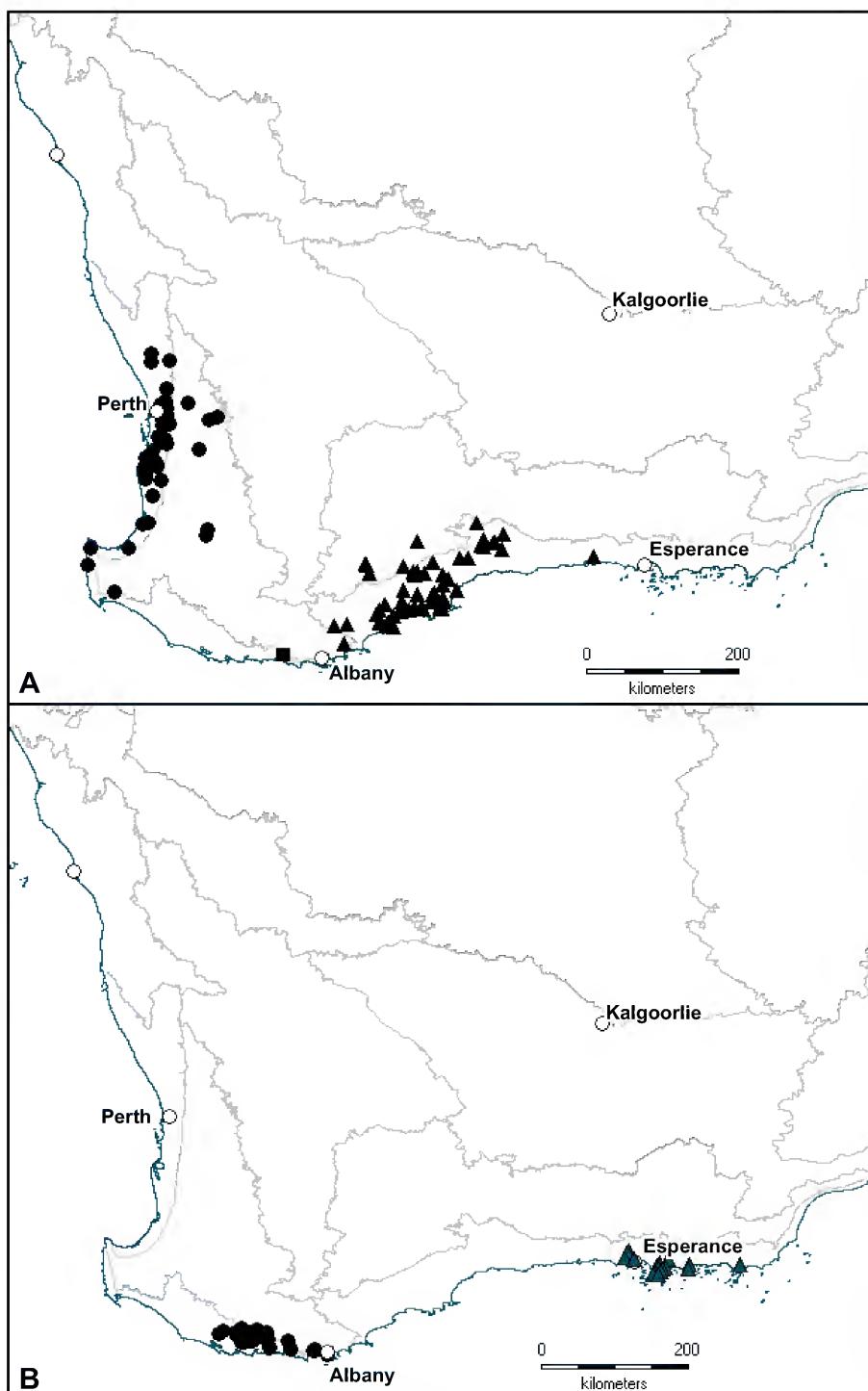


Figure 7. Distributions of *Astartea* species and a presumed hybrid. A – *A. affinis* (●), *A. arbuscula × A. corniculata* (■), *A. aspera* (▲); B – *A. arbuscula* (●), *A. astarteoides* (▲).

habitats than most other species of *Astartea* and, in the rare instances where it sometimes comes into contact with *A. affinis*, differences in flowering time may also be important in maintaining the integrity of the species. *Astartea affinis* (D. Bright & C. Mykytiuk GAA 05 B) was recorded growing with *A. scoparia* (D. Bright & C. Mykytiuk GAA 05 A) at a site in the suburb of Wellard, Perth in early February 2005. The former species was collected in bud and flower while the latter had finished flowering and had fruits attached.

*Notes.* A possible earlier name for this species is *Leptospermum dubium* Spreng. (Sprengel 1825), as discussed under *Doubtful names* below.

Extreme variation of flower size has been observed in a recent field survey of a population near Waroona. A large-leaved and large-flowered variant with numerous stamens and ovules, had previously been distinguished as *A. sp.* Waroona (R.J. Cranfield 11429). However, the large-flowered variant was found to intergrade completely with smaller-flowered specimens in this population. Flower colour also varied considerably there, from almost white to medium pink. The largest flowers recorded elsewhere for *A. affinis* are in two specimens from near Pinjarra (G.J. Keighery 13135 & 14053), with petals 2.5–3 mm long and flowers up to 8.5 mm diam.

*Astartea affinis* also appears to be extremely variable in the degree of horning on the sepals, sometimes within a single population; for example some of the material collected from a population near Jandakot (G.J. Keighery 12756) has long horns and uniformly long leaves (a single piece on the left side of the specimen) while the remainder (two pieces) has short horns and shorter leaves on average.

***Astartea arbuscula* (R.Br. ex Benth.) Rye, *Nuytsia* 16: 152 (2006).** *Baeckea arbuscula* R.Br. ex Benth., *Fl. Austral.* 3: 79 (1867). *Type:* King George Sound, Western Australia [precise locality withheld for conservation reasons], December 1801, R. Brown s.n. (*holo*: BM 000758991; *iso*: K, NSW 497662).

*Illustrations.* S.J. Patrick & S.D. Hopper, *A guide to the gazetted rare flora of Western Australia: Supplement 1*, report No. 54: 15 (1982); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West 2*: 689 (2002) [as *Baeckea arbuscula* in both publications].

Dwarf or small shrub 0.1–0.3(–0.4) m tall, widely spreading at maturity (often with some stems widely spreading or trailing) and usually broader than high, fairly dense, single-stemmed at base, without a lignotuber; young (actively growing) stems not or scarcely winged; older stems with strips of pale grey epidermis or fully dark red-brown except for small patches of grey below each axil. Leaves spreading, mostly distant, almost straight or slightly incurved. Petioles 0.3–0.6 mm long, poorly defined. Leaf blades narrowly or very narrowly obovate from side view, 2.5–5 mm long, 0.25–0.4 mm wide, 0.4–0.6 mm thick, acute or almost acute, mucronate, smooth or somewhat rugose. Inflorescence usually of many pairs of flowers per main branchlet, with 1 or several pairs clustered on the much shorter lateral branchlets. Peduncles slightly to strongly recurved, 0.5–1.5 mm long. Bracteoles 0.3–0.45 mm long, up to 0.2 mm wide, rather scariosus and reddish throughout, entire; apex usually somewhat hooded, with midrib terminating in a mucro or short point. Pedicels absent or up to 0.3 mm long. Buds with a 5-lobed apex. Flowers 1.5–2 mm diam. Hypanthium somewhat bilaterally compressed and lop-sided, longer on the abaxial edge than the adaxial one, 0.5–0.7 mm long, c. 1 mm wide; adnate portion usually irregularly broadly 5-ribbed and somewhat rugose, with large oil glands; free portion 0.1–0.2 mm long. Outer sepals 0.15–0.3 mm long, 0.25–0.5 mm wide, dorsally ridged; scariosus margin narrow, entire to minutely laciniate. Petals 0.4–0.6 mm long, pale to deep pink; margin minutely denticulate to entire. Androecium of (4)5 stamens, usually one opposite each of the sepals but sometimes one

sepal lacking a stamen; filaments free, 0.1–0.25 mm long; anthers c. 0.15 mm long; staminodes absent. Ovary functionally 1-locular, with a very reduced adaxial loculus, the fertile loculus large and abaxial; placenta very reduced and close to top of ovary; ovule 1. Style displaced towards the adaxial side of ovary summit, 0.4–0.6 mm long, the base not or scarcely immersed; stigma less than 0.1 mm wide. Fruits indehiscent, largely inferior, somewhat compressed, lop-sided with end furthest from stem forming a slight ‘beak’, 0.5–0.7 mm long, 0.8–1 mm wide, 1-seeded. Seed oblique, irregularly ovoid, with the narrower end occupying the ‘beak’ of the fruit, 0.6–0.7 mm long, 0.45–0.5 mm thick; testa very thin, ± membranous, off-white to golden brown, smooth.

*Diagnostic features.* Low, single-stemmed shrub occurring in winter-wet depressions. Flowers 1.5–2 mm diam. Sepals dorsally ridged. Petals 0.4–0.6 mm long, pale to deep pink. Stamens (4)5. Staminodes absent. Ovary functionally 1-locular, 1-ovulate. Seeds with a very thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: Dec. 1902, C.R.P. Andrews s.n. (NSW); 5 Jan. 1903, C.R.P. Andrews 1276 (PERTH); 9 Feb. 1995, A.R. Annels 5299 & R.W. Hearn (PERTH); 13 Feb. 1995, A.R. Annels 5309 (PERTH); Feb. 1899, B.T. Goadby s.n. (K); 15 Oct. 1996, M.S. Graham 637 B & M.D. Carter (PERTH); 28 Mar. 2000, B.G. Hammersley 2432 (PERTH); 5 Aug. 1994, R.W. Hearn 4385 (PERTH); 10 Sep. 1986, G.J. Keighery 8361 (PERTH); 4 Dec. 2002, B.L. Rye 221245 & R.W. Hearn (PERTH).

*Distribution and habitat.* Extends along the south coast from the Pingerup Plains area east to Kalgan River (Figure 7B). Found on pale grey sand to peaty black sandy clay on winter-wet flats in heath, associated with other wetland shrubs such as *Pericalymma* species, often in paperbark (*Melaleuca*) woodlands, with open low sedgeland or tall sedges.

*Phenology.* Flowers recorded mainly from late December to mid-March.

*Common name.* Minute Astartea.

*Conservation status.* Priority Four under the Department of Environment and Conservation’s (DEC) Conservation Codes for Western Australian Flora (Smith 2012). This species was previously poorly collected, probably mainly because of its very small stature and inconspicuous leaves and flowers, the latter so minute that it is hard to tell when the plant is flowering. It was included, as *Baeckea arbuscula*, among the Declared Rare Flora treated in Patrick and Hopper (1982), who stated that it had not been collected since 1936. This prompted a search for the species and two populations were located in 1986, together with the first collections of a new species, *A. transversa*, which had only slightly larger flowers. Both taxa were considered to be *B. arbuscula*, as in the report on endangered flora for the Albany district (Robinson & Coates 1995). *Astartea arbuscula* is now known from many collections over a range of c. 135 km, including several national parks.

*Etymology.* From the Latin *arbuscula* (shrub), referring to the habit of this erect, single-stemmed subshrub.

*Affinities.* See the notes under two other taxa that can have a functionally unilocular ovary, *A. transversa* and *A. zephyra*. *Astartea arbuscula* appears to have closer affinities to the latter species than to *A. transversa*. However, it is similar to *A. transversa* in having very short stamen filaments and a

maximum of one stamen opposite each of the sepals, whereas *A. zephyra* has more numerous stamens and longer filaments.

*Co-occurring taxa.* This species is found with various other *Astartea* species at most or all of its localities. However, it tends to be somewhat isolated from most other taxa as it occurs in the more water-logged parts of winter-wet depressions where there is normally only very low-growing vegetation. It appears to be able to hybridise with *A. corniculata*, which also extends into the more water-logged parts.

*Notes.* While it was included in the genus *Baeckea*, this species had the common name Albany Baeckea, since its earliest collections came from Albany. It would be more appropriate to have a common name referring to its minute habit and flowers; hence the one chosen here is Minute *Astartea*.

*Astartea arbuscula* has exceptionally small flowers, the smallest in the tribe and in the entire family. It is most unusual, perhaps unique, in having a bilaterally compressed, lop-sided hypanthium, and it shows the greatest uniformity of stamen number in the genus, with most or all flowers having five stamens.

***Astartea aspera*** Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 114 (1844). *Type:* ‘In rupestribus collium Konkoberup promontorii Cape Riche’ [rocky site, Mt Melville, near Cape Riche, Western Australia], 20 November 1840, L. Preiss (Herb. Preiss No.) 361 (*holo*: LD).

Spreading shrub, 0.15–1 m tall, single-stemmed at base but tending to be multi-branched from or just above the ground level, often with trailing stems as well as more erect ones, muricate on stems and often also leaves and peduncles; young (actively growing) stems usually prominently muricate, with glands modified into crown-like outgrowths, these only rarely rather obscure; older stems with pale grey epidermis usually retaining obvious crown-like protrusions, the epidermis irregularly splitting and shed lower down to reveal a brown, fibrous layer. Leaves moderately spreading, often crowded or in fascicles. Petioles 0.5–0.8 mm long. Leaf blades linear to narrowly obovate in outline, 2.5–11 mm long, 0.5–0.8 mm wide, 0.7–1.1 mm thick, obtuse, often somewhat muricate. Inflorescence of 1–10 pairs of flowers per branchlet, flowers tending to be clustered towards the end of the branchlet. Peduncles 1-flowered, 1–5 mm long, often muricate. Bracteoles deciduous or persistent, 0.7–1.7 mm long, 0.3–0.4 mm wide, hooded, largely scarious, the margin entire; point absent. Pedicels 0.5–2 mm long. Flowers 6.5–12 mm diam. Hypanthium 1.7–2.2 mm long, 2.5–3.5 mm diam.; adnate portion not or scarcely pitted; free portion 0.4–0.6 mm long. Outer sepals 0.5–1.3 mm long, 1.2–1.7 mm wide, smooth to prominently ridged dorsally; scarious margin often deep pink or reddish, entire. Petals 2–4 mm long, pale pink or white; margin entire. Androecium of 15–35 stamens, usually all in distinct fascicles of 2–10 opposite the sepals but sometimes reduced to a solitary stamen opposite one or two sepals, or sometimes with connections between the stamen fascicles and then sometimes with a solitary stamen opposite 1 or 2 of the petals; filaments connate for up to 0.5 mm, the longest 0.7–1.7 mm long; anthers 0.25–0.4 mm long; staminodes few or absent, on the margin of a stamen fascicle, up to 2 mm long. Ovary 3(4)-locular; ovules (6)7–12(–14) per loculus. Style 1.3–2.4 mm long, the basal 0.4–1 mm immersed; stigma 0.25–0.5 mm wide. Fruits 3(4)-locular, 1.8–2 mm long, 3 mm diam.; abortive ovules/seeds brown to dark red-brown. Seeds usually 1–5 per loculus, 0.7–1.3 mm long, 0.5–0.7 mm thick; testa moderately thick, uniformly medium brown to very dark red-brown, reticulate-pitted or colliculate (usually shallowly pitted on viable seeds), contrasting with a white or off-white inner protrusion.

*Diagnostic features.* Single-stemmed or basally branched shrub associated with various winter-wet habitats, often with muricate stems. Flowers 6.5–12 mm diam. Sepals smooth to prominently ridged.

*Petals* 2–4 mm long, white or pale pink. *Stamens* 15–35. *Staminodes* usually absent. *Ovary* 3-locular; ovules 6–14 per loculus. *Seeds* with a thick testa, dark red-brown, reticulate-pitted.

*Distribution.* Extends from the South Stirling area north-east to Phillips River (Figure 7A).

*Etymology.* From the Latin *asper* (rough), referring to the rough texture of the stem and leaves caused by the stellate protrusions.

*Common name.* Rough-stemmed Astartea.

*Affinities.* *Astartea aspera* is closely related to *A. muricata* and *A. cicatricosa*. The former two species can usually be readily distinguished from *A. cicatricosa*, and also from all other members of the genus, by the crown-like outgrowths on the young stems and sometimes also on the peduncles and young leaves. Turczaninow (1852) recognised a third strongly muricate species, *A. clavulata* (see under subsp. *aspera*), choosing this epithet apparently to reflect the leaf shape. He considered *A. clavulata* to be distinguished from *A. aspera* in having more numerous stamens per fascicle, and from *A. muricata* in having the sepals with a particularly prominent dorsal ridge and the pedicels tending to be longer than the peduncles, which were shorter than the leaves, whereas *A. muricata* had a relatively smooth dorsal surface to the sepals and long peduncles that were about as long as the leaves and longer than the pedicels. The type of *A. clavulata* evidently had a semi-prostrate habit, with the stem outgrowths less obvious than on the type specimens of both *A. aspera* and *A. muricata*. While *A. muricata* is maintained here as a distinct taxon, as discussed under its description below, *A. aspera* is now known to be very variable in stamen number and *A. clavulata* is treated as a synonym.

*Hypocalymma asperum* Schauer, which overlaps considerably in range with *A. aspera*, has very similar muricate stems; this convergence led Schauer (1844) to choose the same epithet for the two species.

*Co-occurring taxa.* At one locality near Cape Riche *A. aspera* has been recorded with *A. laricifolia*, but how commonly it occurs with other species is not known.

*Notes.* A few specimens of *A. aspera* are described on the labels as being lignotuberous, but this needs confirmation as no herbarium specimens are of whole plants. Plants examined in the field in the current study were single-stemmed but with the older plants multi-branched at the base, a characteristic that can be readily mistaken for a lignotuberous habit. The species is very variable and two subspecies are recognised.

### ***Astartea aspera* subsp. *aspera***

*Astartea clavulata* Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersburg* 10: 333 (1852).  
*Type:* Swan River Colony [Stirling Range to Cape Riche and Mt Barren Range, Western Australia], 1848–1849, J. Drummond coll. 5, n. 128 (*holo*: KW n.v., photograph PERTH 07523610; *iso*: K (three sheets), NSW 531335, PERTH 01605097).

*Illustration.* B.L. Rye & M.E. Trudgen, *Nuytsia* 18: 244, Figure 3A (2008).

Spreading shrub, 0.15–1 m tall, often with trailing stems as well as more erect ones; young (actively growing) stems prominently muricate. *Petioles* 0.5–0.7 mm long. *Leaf blades* linear to narrowly obovate in outline, 2.5–5(–8) mm long, 0.5–0.8 mm wide, 0.7–0.9 mm thick, often somewhat muricate.

*Peduncles* 1–2.5 mm long, often muricate, often exceeded by or not much longer than the pedicels. *Bracteoles* 0.7–1.3 mm long. *Flowers* 6.5–11 mm diam. *Outer sepals* 0.5–1.3 mm long, 1.2–1.7 mm wide, smooth to prominently ridged dorsally. *Stamens* 15–33. *Ovules* (6)7–12 per loculus. *Style* usually 1.3–2 mm long. *Seeds* 0.8–1.3 mm long, shallowly pitted on viable seeds and contrasting with a white or off-white inner protrusion. (Figure 4A)

*Diagnostic features.* Spreading shrub with prominently muricate stems. *Leaves* 2.5–5(–8) mm long. *Peduncles* 1–2.5 mm long. *Stamens* 15–33. *Ovules* 6–12 per loculus.

*Selected specimens examined.* WESTERN AUSTRALIA: S of Ongerup on the border to Jerramungup, Green Range Rd, 24 Oct. 1969, *A.M. Ashby* 3080 (AD); Bremer Bay Rd off Hassel Hwy, 29 Oct. 1983, *E.J. Croxford* 3175 (PERTH); Mt Melville near Cape Riche, 26 Oct. 1965, *A.S. George* 6903 (PERTH); South Stirling Nature Reserve, 24 Oct. 1991, *G.J. Keighery* 12560 (PERTH); Wellstead, 40 m along a small vehicular track opposite the Wellstead shops, 23 Oct. 1997, *N. Lam & Peter G. Wilson* (UNSW 23732); 15 mi [24 km] S Mt Toolbrunup, 8 Nov. 1964, *K.R. Newbey* 1701 (PERTH); road from Bremer Bay to Gairdner River, 12 Sep. 1971, *S. Paust* 641 (PERTH); Mettler Lake Rd, at junction of Cape Riche Homestead Rd, 7 Jan. 2010, *B.L. Rye* 290139 (PERTH); ‘King George Sound’, 1888, *Webb s.n.* (MEL).

*Distribution and habitat.* Extends from the South Stirling area north-east to Fitzgerald River National Park. Grows in a variety of soil types, often in rocky soil or over a substrate of rocks such as laterite, limestone or granite, in winter-wet depressions or sometimes associated with watercourses, with low heath or shrublands or open mallee woodlands.

*Phenology.* Flowering occurs mainly from August to December, also recorded in January, March and May.

*Conservation status.* A relatively common taxon that is adequately conserved. Its range includes the Fitzgerald River National Park.

*Notes.* This is the only *Astartea* to have been collected at its type locality of Mt Melville, and it is common in the Cape Riche area. Stamen number is very variable in this taxon, especially near Cape Riche. A few specimens along the southern border of the distribution have unusually low stamen numbers, the most extreme being *C.A. Gardner* 6542 in which there are only 1–3 stamens opposite each sepal. The highest stamen numbers known are on northern specimens such as *S. Paust* 641, with up to 8 or possibly more per fascicle.

Specimens (e.g. *R. Davis* 10176) with particularly short peduncles similar to those on the type of *A. clavulata* have been recorded in the southern part of the range from the South Stirling area east to near Point Ann, while specimens with longer peduncles have been recorded throughout the range. Coastal specimens in areas of low coastal vegetation tend to have a lower, more ground-hugging habit than those from more sheltered locations. The sepals are never horned but in many specimens the dorsal surface is very prominently ridged.

Both *R. Davis* 10176 and *R.E. Moir* 25 occasionally have flowers with a stamen directly opposite one of the petals, with the stamens united across that point to the adjacent sepals, although the antisepalous fascicles are still obvious.

**Astartea aspera** subsp. **riparia** Rye, subsp. nov.

*Typus*: at Phillips River crossing on Aerodrome Road, 3.0 km west of Thomas Road, Western Australia, 9 December 2003, B.L. Rye 231212 (*holo*: PERTH 06585922; *iso*: CANB, K, MEL).

*Shrub*, commonly low and spreading and 0.2–0.4 m high but up to 1 m high, recorded up to 2 m wide, single-stemmed at base but often branching close to base, sometimes layering; young (actively growing) stems usually with scattered, crown-like outgrowths. *Leaf blades* linear in outline, 6–11 mm long, 0.6–0.8 mm wide, 0.7–1.1 mm thick. *Petioles* 0.6–0.8 mm long. *Peduncles* 2.5–5 mm long, longer (usually much longer) than the pedicels. *Bracteoles* 0.8–1.7 mm long. *Flowers* 8–12 mm diam. *Outer sepals* 1–1.2 mm long, slightly to prominently ridged. *Petals* 2–4 mm long, pale pink or white. *Stamens* 26–35. *Ovules* 9–14 per loculus. *Style* 1.8–2.4 mm long. *Seeds* 0.7–1.2 mm long, shallowly reticulate-pitted or colliculate.

*Diagnostic features*. Distinguished from subsp. *aspera* by its longer peduncles (2.5–5 mm), also tending to have less muricate stems, longer leaves (6–11 mm) and more numerous stamens (26–35) and ovules (9–14).

*Selected specimens examined*. WESTERN AUSTRALIA: Phillips River, 16 km W of Ravensthorpe, 23 Nov. 1997, B. Archer 899 (PERTH); Fitzgerald River, E of Roes Rock, 18 Dec. 1970, A.S. George 10544 (PERTH); crossing of Phillips River, c. 15 km SW of Ravensthorpe on main road to Ongerup, 18 Sep. 1976, L. Haegi 1039 (NSW, PERTH); Phillips River crossing on Aerodrome Rd, 3 km W of Thomas Rd, 9 Dec. 2003, B.L. Rye 231211 (AD, DNA, PERTH); Lort River crossing, South Coast Hwy, c. 300 m S of bridge, 22 Oct. 1997, Peter G. Wilson 1424 (NSW, PERTH).

*Distribution and habitat*. Extends from Fitzgerald River east to Lort River, often on the rocky banks of watercourses. The type collection was made from soil pockets and crevices in granite along a river bank, in vegetation dominated by *Melaleuca*.

*Phenology*. Flowers mainly September to December.

*Conservation status*. Not currently considered to be at risk. Its known range is about 170 km long and includes some large populations.

*Etymology*. From the Latin *ripa* (the bank of a stream), as most or all occurrences are on the banks of watercourses.

*Notes*. This subspecies occurs north-east and east of the range of *A. aspera* subsp. *aspera* and, unlike that subspecies, is apparently always associated with watercourses and has been known to reproduce by layering. It has longer peduncles than the typical subspecies and also tends to have longer leaves and more numerous stamens and ovules.

Specimens from Fitzgerald River to Phillips River have noticeable crown-shaped outgrowths on the stems, although these are usually less well developed than in specimens of subsp. *aspera*. Specimens occurring further east show the least development of these outgrowths, which are widely scattered and often not very obvious.

***Astartea astarteoides*** (Benth.) Rye, *Nuytsia* 16: 153 (2006). *Baeckea astarteoides* Benth., *Fl. Austral.* 3: 80 (1867). *Type*: inland from Cape Le Grand, [Western Australia,] s. dat., G. Maxwell s.n. (*lecto*: K, *fide* B.L. Rye, *Nuytsia* 16: 153 (2006); *isolecto*: MEL 72507). *Excluded syntypes*: King George Sound, [Western Australia], December 1801–January 1802, R. Brown s.n. (BM 000758990); King George Sound, [Western Australia], December 1821, A. Cunningham 135 (K, PERTH 07016042); along the coast from Bremer Bay to Esperance, [Western Australia], G. Maxwell s.n. (MEL 72508).

Very open spindly shrub when growing amongst and supported by thick vegetation, somewhat more bushy when on open ground, 0.4–1.5 m high, with a single slender stem at base; young (actively growing) stems with 4 distinct, narrow wings 0.15–0.2 mm wide; older stems not winged, pale grey throughout at first. Leaves mostly in fascicles on lower parts of main branchlets and often also in fascicles on newer growth, mostly widely spreading, straight or slightly recurved. Petioles 0.4–0.8 mm long. Leaf blades narrowly or very narrowly obovate from side view, 3–5 mm long, 0.5–0.9 mm wide, 0.6–1 mm thick, obtuse and often with a distinct mucro, somewhat rugose. Inflorescence mainly of distant pairs of flowers or with 1 or several pairs of flowers on each short, lateral branchlet. Peduncles usually fairly straight or somewhat recurved, 2–4 mm long. Bracteoles 1.4–1.7 mm long, 0.25–0.35 mm wide, with apex recurved and sometimes very shortly pointed but not or scarcely hooded; scarious margins narrow, entire. Pedicels 0.5–1.1 mm long. Buds with a somewhat 5-toothed apex. Flowers 4.5–6 mm diam. Hypanthium 1.3–1.5 mm long, 1.5–1.8 mm wide; adnate portion reticulate-pitted and often with ribs opposite the sepals; free portion 0.3–0.4 mm long. Outer sepals 0.35–0.6 mm long, 0.7–1 mm wide, dorsally ridged; scarious margin minutely laciniate or entire. Petals 1.5–1.7 mm long, pink; margin somewhat irregular. Androecium of 5–11 stamens, with one or no stamens opposite 1–3 of the sepals and up to 3 opposite the other sepals, usually not or only partially united into fascicles; filaments free or nearly free, 0.4–0.5 mm long; anthers c. 0.25 mm long; staminodes absent or rare. Ovary 3-locular; ovules 6–8 per loculus. Style 0.8–1.1 mm long, the base immersed for 0.4–0.5 mm; stigma c. 0.2 mm wide. Fruits 3-valvate, c. 1.5 mm long, c. 2 mm diam.; hypanthium somewhat 3-lobed; undeveloped ovules/seeds dark red-brown. Seeds up to 4 per loculus, 0.6–0.9(–1.1) mm long, 0.35–0.5 mm thick; testa thin, golden brown to tan, often developing dark red or red-brown to black markings throughout or towards one end.

*Diagnostic features*. Small, single-stemmed shrub associated with watercourses and depressions. Flowers 4.5–6 mm diam.; hypanthium reticulate-pitted. Sepals dorsally ridged. Petals 1.5–1.7 mm long, pink. Stamens 5–11. Staminodes usually absent. Ovary 3-locular; ovules 6–8 per loculus. Seeds with a thin testa, mottled, smooth.

*Selected specimens examined*. WESTERN AUSTRALIA: Lucky Bay, Jan. 1802, R. Brown s.n. (BM 000758989); 12 km WNW of Esperance, on Telegraph Rd at 7.4 km E of Bates Rd or 3.1 km from intersection with South Coast Hwy, 27 Feb. 2006, G.F. Craig 7095 (PERTH); just N of Thistle Cove, 21 Jan. 1966, A.S. George 7531 (PERTH); Cape Le Grand National Park, inland from W side of road to Le Grand Beach, c. 0.5 km S from its junction with Frenchmans Peak turnoff, 22 Dec. 1994, A.S. Gunness 2436 (PERTH); 12.5 km NNE of Mt Arid, Cape Arid National Park, 30 Oct. 1990, G.J. Keighery 11792 (PERTH); adjacent to Helms Arboretum on the Norseman road, 17 km N of Esperance, 24 Oct. 1979, N.S. Lander 1066 (PERTH); Cape Le Grand Rd, 5.6 km N of National Park sign and 6.2 km N of entry gate of Cape Le Grand National Park, 4.3 km S of Merivale Rd, 11 Dec. 2003, B.L. Rye 231243 & C.D. Turley (AD, BRI, PERTH); Lake Rd, Esperance, 19 Oct. 1997, Peter G. Wilson 1407 & N. Lam (NSW, PERTH); Nares Island Beach, near parking area at the end of Nares Island Rd, 21 Oct. 1997, Peter G. Wilson 1414 & N. Lam (NSW, PERTH); Cape Le Grand National Park, 8 Nov. 1994, A. Worz 04.11.08.05 (PERTH).

*Distribution and habitat.* Occurs in near-coastal areas from just west of Esperance east to Cape Arid National Park (Figure 7B). Grows in sandy soils, mainly associated with swamps but sometimes in more rocky locations, with varied wetland-associated vegetation.

*Phenology.* Flowers recorded late October to January.

*Conservation status.* This species has a range c. 140 km long, including two large national parks, and is not considered to be at risk.

*Etymology.* From the genus *Astartea* and Latin ending *-oides* (like), referring to the *Astartea*-like appearance of this species, which was previously considered to belong in the genus *Baeckea*.

*Affinities.* *Astartea astarteoides* belongs to the *A. montana* species group and is part of the *A. glomerulosa* complex. It has a maximum of three stamens opposite each sepal and sometimes appears to have as few as five stamens per flower, in which case there are no stamens opposite at least one of the sepals. It is geographically separated from *A. glomerulosa*, but that very variable taxon includes some variants with few stamens that are very similar to *A. astarteoides*. The usually more numerous stamens in *A. glomerulosa* have a much greater tendency to be united into fascicles of two to five. *Astartea glomerulosa* tends to have longer peduncles, larger flowers and more numerous ovules. It might be more appropriate to treat these two taxa as subspecies, but the *A. glomerulosa* complex needs to be revised before any decisions are made on the status of *A. astarteoides*.

The broad disjunction between the taxa treated here as *A. astarteoides* and *A. glomerulosa* is one that is seen in a number of other species or species complexes, such as *Thryptomene saxicola* (A.Cunn. ex Hook.) Schauer and *Pimelea clavifolia*.

*Co-occurring taxa.* This species seems to be mostly isolated from other *Astartea* species but *A. eobalta* Rye occurs within its range. See also the discussion under *A. fascicularis*.

*Notes.* Robert Brown was the first collector of *A. astarteoides* in January 1802. His fruiting specimen from Lucky Bay (BM 000758989) is typical of the species. However, Bentham (1867: 80) listed an R. Brown specimen from Lucky Bay as having ‘a smaller style and stigma’ apparently referring to a different specimen (BM 000758988), which is identified on the specimen label as *Baeckea astarteoides*. The latter specimen is actually of a quite different taxon, currently known as *Baeckea* sp. Esperance (A.G. Gunness 2435).

#### ***Astartea cicatricosa* Rye & Trudgen, sp. nov.**

*Typus:* on the west bank of Jerdacuttup River, south of the swimming pool areas on south side of Springdale Road crossing, which is 5.5 km east of Hopetoun–Ravensthorpe Road, Western Australia, 9 December 2003, B.L. Rye 231218 (*holo*: PERTH 06585973; *iso*: CANB, K, MEL).

*Astartea* sp. Jerdacuttup (A. Strid 21898), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000).

Mid-dense shrub 0.5–1.2 m tall, single-stemmed or multi-branched from the base, sometimes layering; young (actively growing) stems reddish, not or scarcely winged; older stems often with opposite-

decussate stripes of pale grey epidermis (each stripe extending from the base of a leaf down to the next node) but sometimes uniformly pale grey. *Leaves* antorse to widely spreading, widely spaced or in fascicles. *Petioles* 0.4–0.7 mm long. *Leaf blades* linear from side view, 6–19 mm long, 0.6–1.1 mm wide, 0.6–1 mm thick, obtuse. *Inflorescence* commonly of few pairs of flowers per branchlet but sometimes of 10 or more pairs. *Peduncles* 5–7 mm long. *Bracteoles* 0.7–2 mm long, 0.3–0.6 mm wide, reddish with pale margins, scarious, hooded, the margin entire; point absent or rarely up to 0.2 mm long. *Pedicels* 0.5–3 mm long. *Buds* obtuse, not obviously lobed. *Flowers* 7.5–11 mm diam. *Hypanthium* 1.3–1.9 mm long, c. 3 mm wide; adnate portion irregularly rugose-pitted, with minute glands in the pits; free portion 0.4–0.5 mm long. *Outer sepals* 0.7–1.0 mm long, 1.1–1.4 mm wide, smooth or scarcely ridged dorsally; scarious margin deep pink to the inside and white to the outside, entire. *Petals* 2.5–4 mm long, white or pale pink; margin almost entire. *Androecium* commonly of 40–53 stamens, in fascicles of 6–11 stamens opposite sepals and usually with a solitary stamen opposite all or some of the petals; filaments connate for up to 0.6 mm, the longest 1.3–2.2 mm long; anthers 0.2–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 9–14 per loculus. *Style* (1.4–)1.7–2.0 mm long, the basal 0.5–1 mm immersed; stigma 0.25–0.3 mm wide. *Fruits* 3-valvate, 2–2.2 mm long, 3–3.5 mm diam., usually uniformly 3-locular but occasionally with one loculus abortive; hypanthium hemispheric, scarcely 3-lobed; abortive ovules/seeds dark red-brown. *Seeds* up to 6 per loculus, 0.9–1.3 mm long, 0.4–0.5 mm wide, 0.45–0.6 mm thick; testa thick, dark red-brown at maturity, shallowly but distinctly reticulate-pitted. *Chaff pieces* somewhat compressed, dark red, often with slightly colliculate testa. (Figures 3A,B; 4B,C)

*Diagnostic features.* Single-stemmed or basally branched shrub associated with watercourses and depressions. *Flowers* 7.5–11 mm diam. *Sepals* smooth or slightly ridged. *Petals* 2.5–4 mm long, white or pale pink. *Stamens* 40–53. *Staminodes* usually absent. *Ovary* 3-locular; ovules 9–14 per loculus. *Seeds* with a thick testa, dark red-brown, reticulate-pitted.

*Selected specimens examined.* WESTERN AUSTRALIA: Fence Rd, 11 km N of Springdale Rd intersection, 19 Jan. 2006, L. Ang & S. Kern 10358 (PERTH); Woodendup Pool, 21 Nov. 1997, M. Bennett 25 (PERTH); c. 100 m E of Carlingup Rd, 12.1 km from Ravensthorpe–Esperance road, 22 May 1999, M. Bennett 473 (PERTH); Hopetoun airstrip, turnoff on road 5.8 km N of Hopetoun, 21 Oct. 2000, M. Bennett 638 (PERTH); 1 km S of Springdale Rd, 21 Jan. 2005, G. Cockerton 10521 (PERTH); 0.3 km E along track to Dunns Swamp, 4.2 km N of Hopetoun, 19 Feb. 2002, R. Davis 10264 (PERTH); Moolyal Creek reserve near Mt Short, N of Ravensthorpe, 11 Mar. 1988, S.D. Hopper 6342 (PERTH); near crossing of Yallobup Creek on Mason Bay Rd, 1.0 km S of Springdale Rd, 9 Dec. 2003, B.L. Rye 231222 (AD, BRI, PERTH); 33 km along Springdale Rd, off Hopetoun–Ravensthorpe Rd, 2 Jan. 1983, A. Strid 21898 (PERTH).

*Distribution and habitat.* Extends from the upper Jerdacuttup River (north of Ravensthorpe Range) south to near Hopetoun and east to Lake Shaster (Figure 8A). Recorded along watercourses and on the margins of swamps, always in very damp locations, with varied other species associated with wetlands, and often with *Melaleuca* species, such as *M. cuticularis*, dominant.

*Phenology.* Flowers mainly from late October to January, also recorded February, April and May.

*Conservation status.* Not currently considered to be at risk. It is geographically restricted, with a known range c. 75 km long, but appears to be fairly common within that area.

*Etymology.* From the Latin *cicatricosus* (full of scars), referring to the numerous pits over the surface of the seeds.

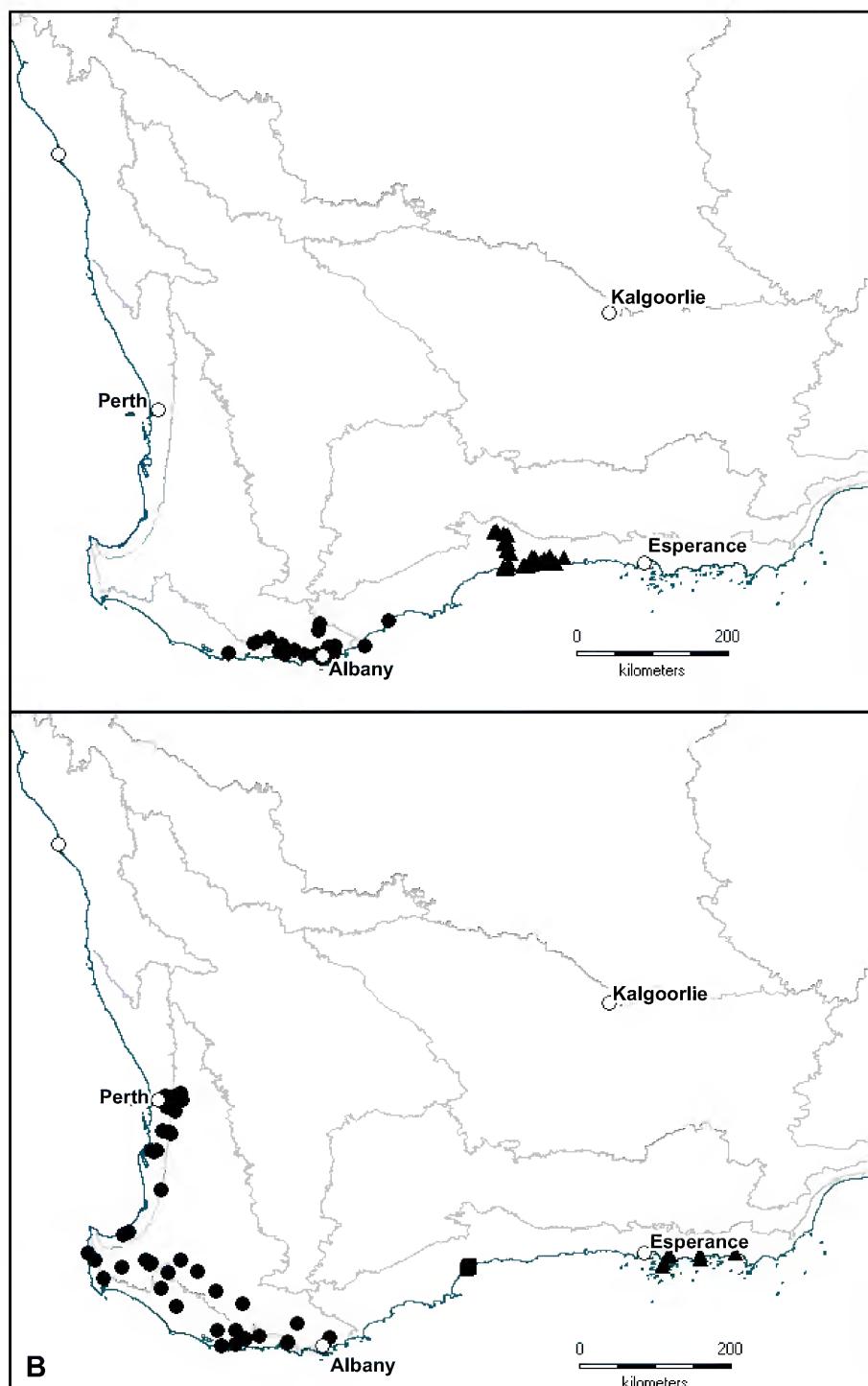


Figure 8. Distributions of *Astartea* species. A – *A. cicatricosa* (▲), *A. corniculata* (●); B – *A. decemcostata* (■), *A. eobalta* (▲), *A. leptophylla* (●).

*Affinities.* This species belongs to the *A. aspera* group, in which the mature viable seeds have a thick testa. It differs from the few other members of this group in having more numerous stamens, usually also with a single stamen opposite all or some of the petals, and also in having smoother sepals.

*Co-occurring taxa.* *Astartea cicatricosa* overlaps in range with *A. reticulata* but probably tends to occur in wetter habitats. The two species have occasionally been found in close proximity (G. Cockerton pers. comm.). For example, a single specimen of *A. reticulata* was found near a population of *A. cicatricosa*, perhaps transported there originally by roadworks, while at another locality a single specimen of *A. cicatricosa* was found near a population of *A. reticulata*. No hybrids have been confirmed. *Astartea cicatricosa* can normally be distinguished readily by its smoother sepals, more numerous stamens, smaller anthers that are almost square in outline, and uniformly dark seeds. It probably also tends to have paler flowers.

*Notes.* Most specimens are single-stemmed at the base but one from a rocky riverbank was found to have layered. Specimens occurring along watercourses generally tend to have larger leaves and flowers than those associated with swamps. Typical specimens (including all those known from the banks of watercourses and also many from swamps) have numerous stamens, with a single stamen usually present opposite some or all of the petals as well as fairly large fascicles opposite the sepals. Some of the specimens from the eastern part of the range have fewer stamens and none opposite the petals, but no consistent differences have been found so far to suggest that more than one taxon should be recognised. *A. Strid* 21898 has smaller leaves and flowers than other specimens and occasional abortive loculi, suggesting that it may be a depauperate specimen in a bad season.

The stamen fascicles may be cleft, sometimes widely, at the centre into two more or less equal parts opposite some, but not all, of the sepals.

***Astartea corniculata*** Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 115 (1844). *Type:* ‘In subturfosarenosis planitiae prope vicum Albany’, [somewhat peaty sand on plain near Albany, Western Australia], 6 January 1840, L. Preiss (Herb. Preiss No.) 163 (*holo*: LD; *iso*: MEL 2147399).

Slender shrub 0.3–0.5 m high, 0.5–0.8 m wide, producing multiple slender stems from a thick lignotuber; young (actively growing) stems brown or red-brown and very narrowly 4-winged; older stems uniformly pale grey. Leaves mostly in fascicles on very short lateral branchlets, spreading. Petioles 0.3–0.7 mm long. Leaf blades narrowly obovate to somewhat clubbed from side view, 2.5–4.5 mm long, 0.3–0.5 mm wide, 0.5–0.7 mm thick, obtuse or narrowly obtuse. Inflorescence usually of several to 10 spaced pairs of flowers along a leafy branchlet, rarely with flowers more clustered. Peduncles 1.5–3.5 mm long. Bracteoles incurved, sometimes leaf-like but usually more scarious, broadest towards the apex, 1.2–2 mm long, 0.3–0.4 mm wide, the somewhat hooded apex sometimes with a dorsal point up to 0.2 mm long. Pedicels 1.3–1.8 mm long. Buds 5-horned. Flowers (4–)4.5–6.5 mm diam. Hypanthium 0.8–1 mm long, 1.5–1.8 mm wide; adnate portion minutely rugose-glandular but not obviously pitted; free portion c. 0.3 mm long. Outer sepals 0.9–1.4 mm long (including the horn), 1.0–1.5 mm wide, dorsally distinctly to very prominently horned; scarious margin entire or minutely irregularly indented; horn 0.4–1 mm long. Petals 1.7–2.5 mm long, white or pale pink; margin denticulate. Androecium usually of 15–20 stamens in fascicles of 2–5 opposite the sepals, rarely of far fewer stamens with none or only 1 opposite the sepals; filaments connate for up to 0.4 mm, the longest 0.8–1.2 mm long; anthers 0.2–0.3 mm long; staminodes absent or rare. Ovary usually 2-locular, with adaxial and abaxial loculi of similar or differing sizes, if 3-locular then one loculus sometimes distinctly exceeding the other two; ovules 2–5 per loculus. Style 1.2–1.6 mm long, the basal 0.25–0.4 mm immersed; stigma c. 0.2 mm wide. Fruits 2- or 3-valvate, 1–1.1 mm long, 1.7–2 mm wide; hypanthium somewhat 2-

or 3-lobed; undeveloped ovules/seeds dark red. *Seeds* up to 3 per loculus, irregularly ovoid to very broadly reniform, 0.65–0.8 mm long, 0.4–0.55 mm thick; testa thin, off-white and with irregular red markings at first, becoming more generally reddish.

*Diagnostic features.* Low, lignotuberous shrub occurring in winter-wet depressions. *Flowers* 4–6.5 mm diam. *Sepals* prominently horned. *Petals* 1.7–2.5 mm long, white or pale pink. *Stamens* usually 15–20. *Staminodes* usually absent. *Ovary* 3-locular; ovules 2–5 per loculus. *Seeds* with a thin testa, mottled, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: N of Hunwick Rd, 11 km ENE of Denmark, 7 Mar. 1990, A.R. Annels 1110 (PERTH); Collingwood Rd East, 20 Feb. 1980, E.J. Croxford s.n. (CANB n.v., K.n.v., PERTH); swamp beside track along W fence, gravel reserve, Howell Rd, off South Coast Hwy, W of Albany, 20 Jan. 1996, E.J. Croxford 7225 (PERTH); Attwell Park Reserve, Reddale Rd off Albany Hwy, 6 km NW of Albany, 22 Feb. 1997, E.J. Croxford 7725 (PERTH); down Gull Rock Rd, 5 km WNW of Nanarup, 12 Dec. 1996, R. Davis 1802 (PERTH); Denmark River, 20 Feb. 1922, C.A. Gardner 1248 (PERTH); King George Sound, Albany, Jan.–Feb. 1854, W.H. Harvey s.n. (PERTH); 15 km NE Albany on Hassel Hwy, 12 Dec. 1982, K.H. Rechinger 60405 (PERTH); Albany, 25 Feb. 1955, R.D. Royce 5014 (PERTH); on track into Rudgyard Nature Reserve, 0.15 km W of W end of Crusoe Beach Rd, 22 Jan. 2003, B.L. Rye 230131, R.W. Hearn & B.G. Hammersley (PERTH); Ledge Beach Rd, 1.0 km S of Ledge Point Rd, Gull Rock National Park, 8 Jan. 2010, B.L. Rye 290150 (PERTH); W across inlet from Walpole township, c. 60 m from inlet edge, 13 Feb. 1994, M.E. Trudgen 12043 (PERTH).

*Distribution and habitat.* Occurs along the south coast, mainly from Denmark east to near Nanarup, but with an isolated record from Walpole (Figure 8A). Recorded in peaty, sandy swamps, occurring in very low shrubland intermixed with sedges and other wetland plants, in similar very damp habitats to those occupied by *A. arbuscula*, and sometimes occurring intermixed with that species.

*Phenology.* Flowers recorded from mid-December to early March.

*Conservation status.* Not currently considered to be at risk. It occurs in several conservation reserves and most of its populations are fairly large.

*Etymology.* From the Latin *corniculum* (little horn), in reference to the prominent horn on the small sepals.

*Affinities.* Since it has variegated seeds, *A. corniculata* is included in the *A. montana* species group, differing from most members of that group in having a relatively smooth hypanthium and prominently horned sepals. Another species with these hypanthium and sepals characters, *A. schaueri*, can be distinguished from *A. corniculata* by its larger habit, leaves and flowers, and its more numerous stamens and ovules. *Astartea corniculata* differs from almost all other species in that its ovary is usually functionally 2-locular. Some specimens are predominantly 3-locular but have 2-locular flowers as well.

*Co-occurring taxa.* This species normally occurs with other *Astartea* species in swampy habitats along the part of the south coast with the highest rainfall. The co-occurring species include *A. glomerulosa*, which tends to flower earlier than *A. corniculata*, and several members of the *A. scoparia* group. One species of the latter group, *A. arbuscula*, appears to be able to hybridise with *A. corniculata* (see *Presumed hybrids* below).

*Notes.* The isolated Walpole collection (M.E. Trudgen 12043) of *A. corniculata* has far fewer stamens than all other specimens, apparently with only one stamen or none opposite each sepal as in *A. arbuscula* and *A. transversa*. The taxonomic status of the Walpole variant of *A. corniculata* is unclear as it is known only from one collection. More fieldwork is needed in the poorly surveyed area surrounding Walpole, and extending eastwards to determine whether the apparent disjunction between Walpole and Denmark is real.

***Astartea decemcostata* Rye, sp. nov.**

*Typus:* Fitzgerald River National Park, Western Australia [precise locality withheld for conservation reasons], 27 November 2002, M. Hislop 2867, S. Barrett & J.A. Cochrane (holo: PERTH 06236510; iso: CANB, K, MEL).

*Astartea* sp. Barren Range (S. Barrett 340.5), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

*Shrub* 0.7–1.8 m high, 0.5–1.5 m wide, single-stemmed at the base; young (actively growing) stems narrowly or very narrowly winged; older stems with thickened pale grey epidermis below each node and more reddish layer between, soon becoming largely brown but retaining the pale grey strips below each node. *Leaves* mostly in fascicles (except on young, rapidly growing stems), slightly incurved to slightly outcurved. *Petioles* 1–1.5 mm long, poorly defined. *Leaf blades* linear in outline, 8–12 mm long, 0.4–0.5 mm wide, 0.5–0.6 mm thick, acute, somewhat wrinkled-rugose. *Inflorescence* commonly of 2–4 pairs of flowers per main branchlet. *Peduncles* 3–5 mm long. *Bracteoles* 3–4 mm long, 0.35–0.5 mm wide, with a hooded apex, acute or with a slight terminal point; scarious margins incurved, narrow. *Pedicels* 1.5–2.5 mm long. *Buds* 5-toothed to 5-lobed. *Flowers* 7.5–10 mm diam. *Hypanthium* 1.5–2.5 mm long, up to c. 3 mm wide, usually distinctly broadly 5–10-ribbed (at least some flowers 10-ribbed); adnate portion gland-dotted but not very reticulate-pitted; free portion 0.6–0.8 mm long. *Outer sepals* 0.5–0.8 mm long, 1–1.4 mm wide, the outer ones strongly ridged to shortly horned; scarious margin narrow; horn up to 0.3 mm long. *Petals* 3–4 mm long, pale or very pale pink; margin almost entire. *Androecium* of 30–34 stamens, in fascicles of 4–9 opposite the sepals; filaments connate for up to 0.6 mm, the longest 1–1.3 mm long; anthers 0.2–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 7–9 per loculus. *Style* 1.3–1.5 mm long, the basal c. 0.5 mm immersed; stigma c. 0.3 mm wide. *Fruits* 3-valvate, c. 2 mm long, c. 3 mm diam.; hypanthium 3-lobed. *Seeds* irregularly ovoid, 0.7–0.8 mm long, c. 0.5 mm thick; testa moderately thick, golden brown to greyish brown, with a dark reticulate pattern resulting from darkened cell margins or mottled, with the cell margins slightly raised. *Chaff pieces* dark red-brown. (Figure 3C)

*Diagnostic features.* Single-stemmed shrub, growing on rocky hillsides. *Flowers* 7.5–10 mm diam.; hypanthium commonly 10-ribbed. *Outer sepals* strongly ridged to very shortly horned. *Petals* 3–4 mm long, pale or very pale pink. *Stamens* 30–34. *Staminodes* usually absent. *Ovary* 3-locular; ovules 7–9 per loculus. *Seeds* with a moderately thick testa, mottled.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 14 Nov. 1995, S. Barrett 340.5 (PERTH); 28 Nov. 2002, M. Hislop 2886, S. Barrett & J.A. Cochrane (PERTH); 29 Nov. 2002, M. Hislop 2888, S. Barrett & J.A. Cochrane (PERTH).

*Distribution and habitat.* Known from gullies on the lower slopes of two peaks in the Barren Range, occurring in winter-wet brown or grey sandy soil over quartzite in mallee woodlands or in shrublands

(Figure 8B). Associated species recorded at one or more of the sites include *Eucalyptus conferruminata*, *Agonis obtusissima*, *Allocasuarina trichodon*, *Hakea hookeriana*, *Acacia myrtifolia* and *Baumea preissii*.

*Phenology.* Flowers from mid-November to early December.

*Common name.* Barrens Astartea.

*Conservation status.* Recently listed as Priority Two under DEC Conservation Codes for Western Australian Flora under the name *A. sp.* Barren Range (S. Barrett 340.5) (Western Australian Herbarium 1998–). Known from three populations in a very small area within a large national park.

*Etymology.* From the Latin *decem* (ten) and *costa* (rib), referring to the tendency for the hypanthium to be 10-ribbed.

*Affinities.* Belongs to the *A. aspera* group and shows greatest similarity to *A. reticulata*, differing in its longer petioles and leaf blades and usually 10-ribbed hypanthium. The two species overlap in range but occupy different habitats. The seed testa of *A. decemcostata* and *A. reticulata* lacks the uniformity of dark colouring found in the other members of the *A. aspera* group and is not as thick, but has thicker cell margins than in other *Astartea* groups.

*Co-occurring taxa.* Not recorded with any other *Astartea* species.

*Notes.* *Astartea decemcostata* is single-stemmed and easily killed by fire (M. Hislop pers. comm.) but regenerates readily from seed. Probably the most notable characteristic of *A. decemcostata* is its multi-ribbed hypanthium (Figure 3C). The hypanthium has five prominent ribs opposite the sepals and up to five, usually not as well developed ones, opposite the petals, a character that distinguishes it from all other species of *Astartea*.

#### ***Astartea eobalta* Rye, sp. nov.**

*Typus:* Cape Le Grand, Western Australia [precise locality withheld for conservation reasons], 9 April 1966, E.M. Scrymgeour 440 (*holo*: PERTH 06172628).

*Astartea* sp. eastern swamps (A.G. Gunness 2434), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Spindly open shrub 0.4–2.5 m tall, single-stemmed at the base and with slender spreading branches; young (actively growing) stems reddish, narrowly or very narrowly 4-winged; older stems with a pale grey epidermis which splits to reveal a reddish brown under-layer. Leaves erect to moderately spreading, widely spaced on some upper flowering stems but often in fascicles elsewhere, slightly incurved to slightly recurved. Petioles 0.5–1.3 mm long, poorly defined. Leaf blades narrowly obovate to almost linear from side view, 5–12 mm long, 0.4–0.8 mm wide, 0.6–0.8 mm thick, acute, somewhat wrinkled-rugose, often with a minute recurved apical point up to 0.3 mm long. Inflorescence commonly of 3–8 pairs of flowers per main branchlet. Peduncles 1.5–3.5 mm long. Bracteoles 1.3–3 mm long, 0.3–0.5 mm wide, with a hooded and dorsally pointed apex; scarious margins c. half as wide as bracteole or broader, entire; point up to 0.4 mm long. Pedicels 1.5–3.5 mm long. Buds 5-toothed to 5-lobed. Flowers 7–8.5 mm diam. Hypanthium 1.8–2.7 mm long, up to c. 3 mm wide; adnate portion usually somewhat broadly 5-ribbed, gland-dotted; free portion 0.4–0.6 mm long. Outer sepals 0.5–0.6 mm long,

0.8–1.2 mm wide, strongly ridged to shortly horned; scarious margin entire; horn up to 0.4 mm long. *Petals* 2–3.2 mm long, pale pink or white; margin minutely lacinate. *Androecium* of 21–31 stamens, in fascicles of 3–8 opposite the sepals; filaments connate for up to 0.4 mm, the longest 0.7–1 mm long; anthers c. 0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 8–14 per loculus. *Style* 1.4–1.8 mm long, the basal 0.5–0.8 mm immersed; stigma 0.3–0.35 mm wide. *Fruits* 3-valvate, 1.6–2 mm long, 1.9–3 mm diam.; hypanthium somewhat 3-lobed; undeveloped ovules/seeds dark red-brown. *Seeds* commonly up to 5 per loculus, 0.7–1.1 mm long, 0.4–0.5 mm thick; testa thin, pale golden brown to greyish brown, uniformly coloured, smooth.

*Diagnostic features.* Single-stemmed or basally branched shrub associated with winter-wet depressions. *Flowers* 7–8.5 mm diam. *Outer sepals* strongly ridged to shortly horned. *Petals* 2–2.7 mm long, pale pink or white. *Stamens* 21–31. *Staminodes* usually absent. *Ovary* 3-locular; ovules 8–14 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 22 Dec. 1994, A.G. Gunness 2434 (PERTH); 22 Dec. 2005, R.M. Hoggart 3/1205 (PERTH); 11 Dec. 2003, B.L. Rye 231244 & C.D. Turley (PERTH); 3 Jan. 1983, A. Strid 21907 (PERTH).

*Distribution and habitat.* Recorded from north of Cape Le Grand east to Dolphin Cove, in seasonal swamps or rarely minor creeklines with sandy soils (Figure 8B). Associated vegetation in the southwest of the known range was recorded as coastal heath and sedgeland, with *A. eobalta* and occasional *Banksia occidentalis* being emergent. The locality sampled in the current study had grey-brown sand on a rise above a swamp, with *Eucalyptus occidentalis* (Swamp Yate) trees over *Melaleuca cuticularis* and *Acacia cyclops* over sedgeland, indicating that the species is likely to be somewhat salt-tolerant.

*Phenology.* Flowers mainly from late October to January, also recorded in April.

*Conservation status.* Recently listed as Priority Two under DEC Conservation Codes for Western Australian Flora, under the name *A. sp. eastern swamps* (A.G. Gunness 2434) (Western Australian Herbarium 1998–). Attempts in 2004 to relocate the species at several road-verge localities were unsuccessful except for one locality where a single plant was found. The species has also been recorded in Cape Le Grand National Park and Cape Arid National Park, its known range c. 80 km long.

*Etymology.* From the Greek *eos* (east) and *balte* (swamp) as this species is associated with wetlands in the eastern part of the range of the genus.

*Affinities.* This species has been confused with *A. fascicularis*, a species restricted to coastal granite, which can be readily distinguished by the more prominent grey thickenings present on its stems, its more numerous stamens, the presence of staminodes, and its higher ovule number.

*Astartea eobalta* is probably like *A. decemcostata* and *A. reticulata* in having a single-stemmed habit, but the former differs in its 10-ribbed hypanthium and habitat, while the latter differs in having fewer stamens; both have a thicker testa on their seeds.

*Co-occurring taxa.* This species occurs within the range of *A. astarteoides* but appears to be geographically isolated from all other species. The two species also have similar flowering times but *A. eobalta* probably tends to occur in damper microhabitats.

*Notes.* Further collections are needed to confirm the habit of this species, as only one plant has been examined to check for a lignotuber, and to determine whether the variation within it indicates that more than one taxon should be recognised. Eastern specimens tend to have smaller bracteoles than western ones and a greater tendency for leaves to be in fascicles. K.R. Newbey 167 appears to have the shortest petals and stamens, and its seeds are shorter and broader than usual.

**Astartea fascicularis** (Labill.) DC., *Prod. 3: 210* (1828). *Melaleuca fascicularis* Labill., *Nov. Holl. Pl. 2*, 29–30, tab. 170 (1806). *Baeckea fascicularis* (Labill.) Nied. in A. Engler & K. Prantl, *Nat. Pflanzenfam.* III, 7: 99 (1893). *Type:* ‘in capite Van-Diemens’ [probably actually collected on Observatory Island, Archipelago of the Recherche, Western Australia], 11–18 December 1792, J.J.H. de Labillardière s.n. (*holo:* FI n.v., illustration seen).

*Illustration.* J.J.H. de Labillardière, *Nov. Holl. Pl. 2: 29–30*, t. 170 (1806) [as *Melaleuca fascicularis*].

Dense *shrub* commonly 0.8–1.5 m when wind-pruned but up to 3 m high in more protected sites, single-stemmed or multi-branched at ground level and layering when opportunity arises; young (actively growing) stems pale red-brown to deep reddish, with narrow ridges or wings to 0.3 mm wide; older stems prominently ridged and pale grey, later developing opposite-decussate stripes of pale grey epidermis (each stripe extending from the base of a leaf down to the next node) alternating with reddish brown stripes, the pale grey epidermis prominently thickened directly below each leaf. *Leaves* slightly curved, mostly in fascicles. *Petioles* 0.8–2 mm long. *Leaf blades* very narrowly obovate from side view, 5–12 mm long, 0.4–0.6 mm wide, 0.4–0.8 mm thick, obtuse. *Inflorescence* of several to many pairs of flowers along the branchlets. *Peduncles* 2–5 mm long. *Bracteoles* 1.3–1.7 mm long, 0.4–0.6 mm wide, the hooded apex sometimes with a small dorsal point up to 0.2 mm long; scarious margins narrow, entire. *Pedicels* 1.6–3.5 mm long. *Buds* with apex fairly flat to distinctly 5-lobed. *Flowers* 8–11 mm diam. *Hypanthium* 1.5–3 mm long, 2.5–3.7 mm wide; adnate portion often broadly 5-ribbed, fairly smooth but with oil glands often slightly protruding; free portion 0.6–1 mm long. *Outer sepals* 0.8–1.2 mm long, 1.6–2.2 mm wide, scarcely to prominently ridged dorsally; scarious margin entire. *Petals* 2.5–4 mm long, white or rarely pale pink; margin entire or almost so. *Androecium* of 30–44 stamens and 10 or sometimes fewer staminodes, in fascicles, with 5–10 stamens per fascicle; filaments connate for up to 0.5 mm, the longest 0.9–2 mm long; anthers 0.2–0.25 mm long; staminodes located at the margins of each fascicle and often distinctly separated from the stamens, either attenuate or with a sterile reduced anther, occasionally flattened and somewhat petaline, usually distinctly longer than the stamens. *Ovary* 3-locular; ovules 14–23 per loculus. *Style* 1.4–2.8 mm long, the basal 0.4–0.7 mm immersed; stigma up to c. 0.4 mm wide. *Fruits* 3-valvate, 2–2.4 mm long, 2.5–3 mm diam.; hypanthium somewhat 3-lobed; abortive ovules/seeds numerous, dark brown. *Seeds* much fewer than the chaff pieces, up to 5 per loculus, not flattened, 0.8–1.1 mm long, 0.3–0.45 mm wide, 0.4–0.6 mm thick; testa thin, pale brown to golden brown, fairly smooth.

*Diagnostic features.* Single-stemmed or multi-branched *shrub* associated with granite. *Flowers* 8–11 mm diam. *Sepals* smooth to prominently ridged. *Petals* 2.5–4 mm long, white or pale pink. *Stamens* 30–44. *Staminodes* occurring on the margins of the fascicles. *Ovary* 3-locular; ovules 14–23 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: Mondrain Island, 19 Nov. 2002, S. Comer 38 (PERTH); Middle Island, 1818, A. Cunningham 17 (PERTH); Thistle Cove, Cape Le Grand National Park, 27 Nov. 1985, D.B. Foreman 1284 (NSW, PERTH); N side of Mt Le Grand, 12 Dec. 1960, A.S. George 2229 (PERTH); Woody Island, 18 Nov. 1998, M. Hislop 1226 (CANB, PERTH); Middle Island, 4 Nov. 2003, R.J. Powell s.n. (PERTH); Wilson Island, 1 Feb. 1960, R.D. Royce 6157

(PERTH); Thistle Cove, Cape Le Grand National Park, 11 Dec. 2003, *B.L. Rye 231246 & C.D. Turley* (AD, BRI, PERTH); along walk trail between Le Grand Beach and Hellfire Bay, 6 Nov. 1982, *A. Strid 21207* (PERTH); Woody Island, Esperance, 12 Dec. 1995, *C.D. Turley & R. Bruhn 28/1295* (PERTH).

**Distribution and habitat.** This species occurs at the south-eastern extreme of the range of the genus, being widespread in the Archipelago of the Recherche, extending from Observatory Island east to Middle Island, also occurring on the mainland coast of the Cape Le Grand National Park (Figure 9A). It grows on somewhat elevated sites with granite, often in exposed, coastal, wind-pruned vegetation but also occurring in well protected sites on the larger islands in dense scrub.

**Phenology.** Flowering is recorded from early November to February.

**Conservation status.** This species is well protected, occurring in a large national park and the Archipelago nature reserve.

**Etymology.** From the Latin *fasciculus* (small fascicle), the protologue noting that both the leaves and stamens are in fascicles.

**Common name.** Recherche Astartea.

**Type details.** No collections have been made of *A. fascicularis* on Observatory Island since 1792, when the island was used as a refuge from bad weather by two French vessels on Labillardière's expedition (Duyker 2003). However, the species does still occur on the island and has been photographed there by Coral Turley (pers. comm.).

**Affinities.** The three species that are found close to the range of *A. fascicularis* all occur mainly in winter-wet swamps rather than on granite; of these *A. eobalta* shows the greatest similarities but differs as discussed under that species.

*Astartea fascicularis* has been confused with *A. montana*, which is also found on rocky locations and regularly has staminodes on the margins of the stamen fascicles. That species occurs in a quite different region, being endemic to the Stirling Range area, and differs in its reticulate-pitted hypanthium and mottled seeds.

**Co-occurring taxa.** Populations occurring on the islands of the Archipelago of the Recherche are completely isolated from other *Astartea* species. On the mainland, *A. fascicularis* also apparently occurs alone, although it has been recorded not far from *A. astarteoides* at Thistle Cove. *Astartea astarteoides* was collected from the edge of a swamp below a granite hill just north of Thistle Cove (*A.S. George 7531*) whereas *A. fascicularis* was found on exposed granite directly on the coast of the cove (e.g. *Peter G. Wilson 1627 & G.M. Towler*).

**Notes.** Despite its extensive distribution on islands, *A. fascicularis* seems to be very restricted in its distribution on the mainland. One characteristic of this species rarely seen in other members of the genus is the strongly developed striping of its older stems with thick, opposite-decussate stripes topped with pale grey epidermis.

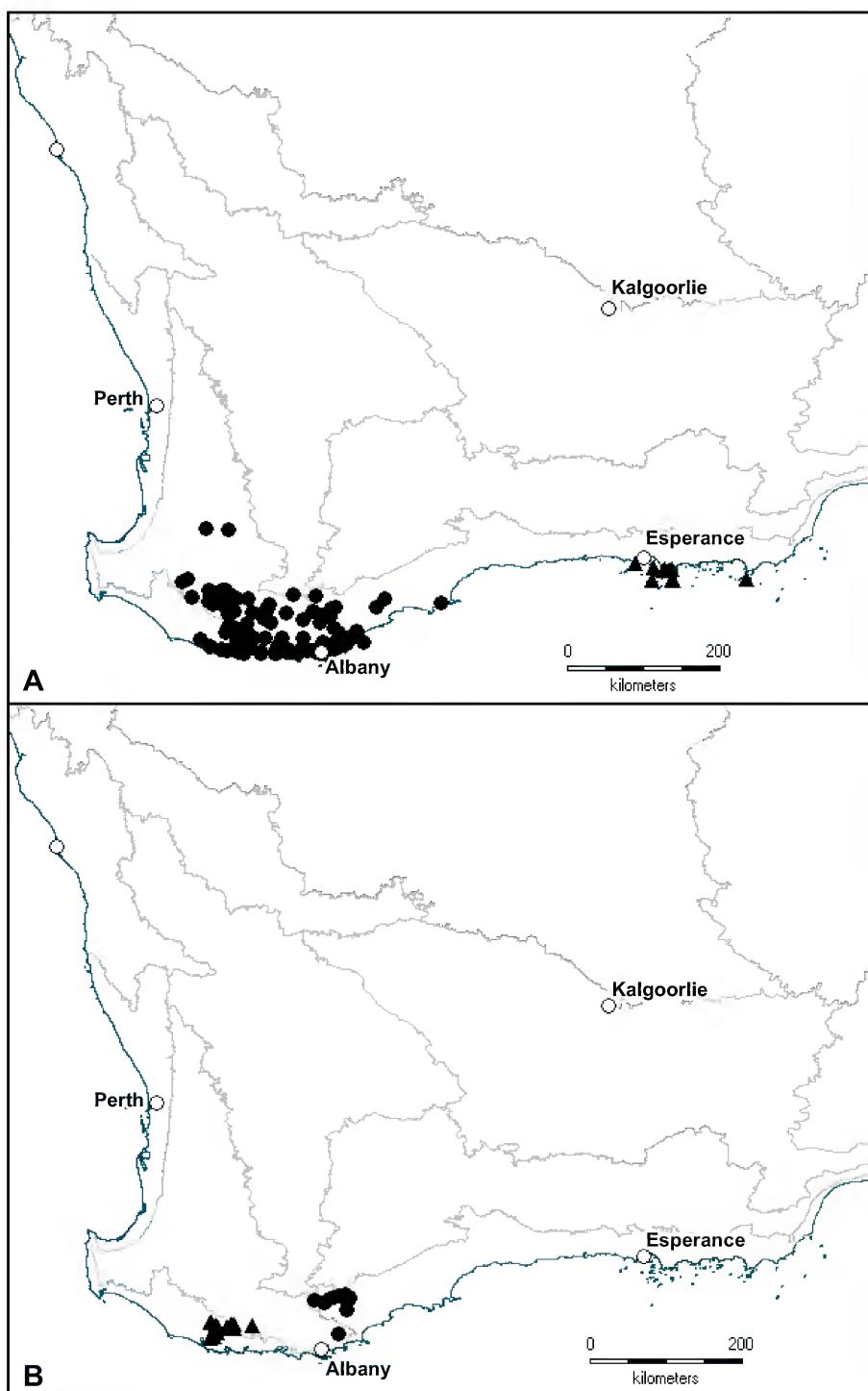


Figure 9. Distributions of *Astartea* species. A – *A. fascicularis* (▲), *A. gomerulosa* (●); B – *A. graniticola* (▲), *A. montana* (●).

***Astartea glomerulosa*** Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 115 (1844). *Type:* ‘In regionibus interioribus Sinus Regis Georgii III’ [inland from King George Sound, Western Australia], 8 November 1840, L. *Preiss* (Herb. *Preiss* No.) 162 (*holo*: LD).

*Astartea* sp. long stalks (D. Foreman 1490), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

*Illustration.* J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *Astartea* sp. long stalks (D. Foreman 1490)].

*Shrub* commonly 0.3–1 m high, single-stemmed at the base, with a tap root and several horizontal main stems radiating just below the soil surface; young (actively growing) stems with 4 distinct narrow wings up to c. 0.2 mm wide; older stems not winged, pale grey throughout at first. *Leaves* mostly in fascicles on the lower parts of main branchlets and often also fasciculate on newer growth, mostly widely spreading, straight or slightly recurved. *Petioles* 0.4–0.8 mm long. *Leaf blades* narrowly or very narrowly obovate from side view, 2–6 mm long, 0.5–0.8 mm wide, 0.7–1 mm thick, obtuse and often with a distinct mucro, somewhat rugose. *Inflorescence* mainly of distant pairs of flowers or with 1 or several pairs of flowers on each short lateral branchlet. *Peduncles* usually fairly straight or somewhat recurved, 2–10 mm long. *Bracteoles* 1–2.1 mm long, 0.3–0.55 mm wide, with apex erect and usually distally hooded; scarious margins narrow, entire; point absent or up to 0.2 mm long. *Pedicels* 1–2.5 mm long. *Buds* often with a somewhat 5-toothed apex. *Flowers* usually 5–8 mm diam. *Hypanthium* 1.2–1.5 mm long, 1.8–2.3 mm wide; adnate portion usually distinctly reticulate-pitted; free portion 0.4–0.5 mm long. *Outer sepals* 0.7–1 mm long, 1–1.6 mm wide, somewhat dorsally ridged to very shortly horned; scarious margin minutely laciniate or entire. *Petals* 1.5–3 mm long, pale to medium pink; margin somewhat irregular. *Androecium* of 15–21 stamens, in groups of 2–5 stamens opposite at least three of the sepals (sometimes with 2 distinct, 2-staminate fascicles opposite a single sepal) and often solitary opposite one or two sepals; filaments connate for up to 0.6 mm, the longest 0.5–1 mm long; anthers 0.2–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 5–9 per loculus. *Style* 0.8–1.4 mm long, the basal 0.4–0.5 mm immersed; stigma 0.25–0.4 mm wide. *Fruits* 3-valvate, 1.4–1.6 mm long, 2–2.5 mm wide; hypanthium hemispheric, scarcely 3-lobed; abortive ovules dark red-brown. *Seeds* often several per loculus, scarcely flattened laterally, 0.7–1 mm long, 0.35–0.45 mm thick; testa thin, golden brown and with dark reddish to ± black minute markings, smooth. (Figure 1C)

*Diagnostic features.* Single-stemmed shrub mainly associated with winter-wet depressions. *Flowers* usually 5–8 mm diam.; hypanthium reticulate-pitted. *Sepals* slightly ridged to very shortly horned. *Petals* 1.5–3 mm long, pale to medium pink. *Stamens* 15–21. *Staminodes* usually absent. *Ovary* 3-locular; ovules 5–9 per loculus. *Seeds* with a thin testa, mottled, smooth.

*Selected specimens examined.* WESTERNAUSTRALIA: near Mitchell River crossing on old Denmark–Mount Barker road, 23 Oct. 1991, A.R. Annels 1780 (PERTH); behind the first dune, Broke Inlet, 19 Dec. 1994, A.R. Annels 5238 & R.W. Hearn (PERTH); Bowelling–Duranillin Rd, near Bowelling, 27 Nov. 1994, V. Crowley 12 (PERTH); Gledhow–Old Denmark Rd, 28 Nov. 1978, E.J. Croxford 57 (PERTH); c. 40 km W of Denmark, 0.5 km N of South Western Hwy, 5 Dec. 1985, D.B. Foreman 1490 (NSW, PERTH); Parry Inlet, 13 Nov. 1960, C.A. Gardner 13039 (PERTH); Peaceful Bay, adjacent to Parry Inlet, 24 Nov. 1990, N. Gibson & M. Lyons 110 (PERTH); upper Blackwood River, 10 Dec. 1877, F. Mueller s.n. (MEL 76017); N side of Lake View Rd, 3.5 km W of Northern Rd and 0.3 km W of Parkinson Rd, 2 Dec. 2002, B.L. Rye 221210 & R.W. Hearn (PERTH); Walpole–Nornalup National Park, 15 Dec. 1991, J.R. Wheeler 2955 (PERTH).

*Distribution and habitat.* Extends from near Bowelling south to Broke Inlet and east to Pallinup River, in deep, sandy soils around the drier margins of swamps and less commonly in shallow soil overlying laterite or granite (Figure 9A). Paperbarks are usually present.

*Phenology.* Flowers mainly from October to mid-December, with some earlier records from August to September and with a few flowers sometimes present on a few plants in January.

*Conservation status.* Not currently considered to be at risk, as it has numerous populations spread over a relatively large range.

*Etymology.* From the Latin *glomeris* (small ball of yarn) and *ulosa* (abounding in), presumably in reference to the ball-like fascicles of short leaves up the stems of the type specimen.

*Common name.* Early Astartea.

*Affinities.* Its closest relative is *A. astarteoides*, these two species forming the *A. glomerulosa* complex. See the notes under *A. astarteoides*.

*Co-occurring taxa.* *Astartea glomerulosa* has been recorded with *A. scoparia* and a number of other *Astartea* species, but tends to occupy drier microhabitats and to flower earlier than the co-occurring species.

*Notes.* The holotype of *A. glomerulosa* is only a fragment with two short branchlets both broken off so their full length is uncertain, with an additional very short unbroken piece possibly from a very short lateral branchlet. This material has small leaves and flowers similar to those of some of the single-stemmed specimens from inland of Albany, such as B.L. Rye 221253. Many of the PERTH specimens differ in having fewer stamens and/or actively growing branchlets with four narrow wings whereas the type appears not to be growing at all, but this may be because the tips have been broken off the type specimen to reduce it to carrying size. Only one flower is open on the specimen, and this appears to have stamens mostly in fascicles of three or four, although one partially hidden fascicle may have only two stamens.

As this species lacks a lignotuber it is vulnerable to fire, but it reproduces readily by seed following fires and other disturbances. It is usually an erect spindly shrub at first, becoming more bushy with age but still with erect to spreading flowering branchlets. A few specimens have a distinctive, weeping habit, but once pressed look very similar to the other specimens. Weeping habit is also found spasmodically amongst other species of *Astartea* and within species of other genera so does not necessarily have any taxonomic significance.

One of the most variable characters within this species, as currently defined, is its peduncle length (or overall stalk length if the pedicel is included). Usually the pedicel is much shorter than the peduncle but if the peduncle is relatively short then the pedicel may sometimes be longer than usual and the two stalks are then of about the same length.

A variant that has fewer stamens than in the above description occurs mainly from Albany to Cheyne Bay, but it apparently intergrades with the variant previously known as *A. sp. long stalks* (D. Foreman 1490).

An entity known as *A. sp.* Lake Muir (B.L. Rye 230128 & R.W. Hearn) differs from the above description in having smaller seeds, 0.5–0.7 mm long. It is restricted to a small area surrounding Lake Muir, occurring in a damper microhabitat and flowering later than the typical *A. glomerulosa* populations that occur in the same general area, and having a more delicate overall appearance. While this taxon appears from field surveys to be a distinct species it cannot be readily distinguished from the many variants of *A. glomerulosa s. lat.* occurring in other areas and the whole complex needs further work to determine how many species should be recognised. In the interim, *A. sp.* Lake Muir is retained on Western Australia's vascular plant census and is listed as having a Priority Two conservation status (Smith 2012).

***Astartea granitica* Rye & Trudgen, sp. nov.**

*Typus:* north of Walpole, Western Australia [precise locality withheld for conservation reasons], 20 December 1995, A.R. Annels 5645 (*holo*: PERTH 04247515; *iso*: CANB, K, MEL).

*Astartea* sp. Mt Johnston (A.R. Annels 5645), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000).

*Shrub* 1.5–3.5 m tall, recorded up to 1.5 m wide, single-stemmed at the base; young (actively growing) stems pale red-brown to dark reddish, 4-ridged at first; older stems with a smooth, shiny, grey, outer layer peeling off to reveal a darker, grey-brown layer. *Leaves* antrorse to widely spreading, almost straight to distinctly curved, mostly in fascicles. *Petioles* 0.8–1.7 mm long, poorly to moderately well defined. *Leaf blades* linear in outline, almost terete towards apex but adaxially somewhat flattened, 7–15 mm long, 0.3–0.5 mm diam., acute, relatively smooth. *Inflorescence* of 1–6 pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 4–13 mm long. *Bracteoles* 4–6 mm long, 2–3 mm wide, reddish with pale scarious margins 1.3–2.5 mm wide, with keel produced into a stout terminal horn; horn recurved distally, 1.2–3 mm long. *Pedicels* 1–3.5 mm long. *Buds* with 5 prominent, erect, pink or reddish horns and often deep pink petals. *Flowers* 10–13 mm diam. *Hypanthium* 2–4 mm long; adnate portion irregularly slightly rugose and with numerous oil glands, scarcely ribbed; free portion 0.4–0.8 mm long. *Outer sepals* 1–1.6 mm long, 1.3–1.9 mm wide, obtuse to irregularly truncate, prominently horned, the herbaceous portions reddish; scarious margin broad, petal-like, almost entire to distinctly toothed; horn very broad-based and sometimes with a downwards basal projection, distally incurved, 0.6–1.5 mm long. *Petals* 4–5 mm long, white or pale pink; margin minutely crenulate to distinctly denticulate. *Androecium* usually of 28–40 stamens, in fascicles of 5–10 opposite the sepals, sometimes also with solitary staminodes opposite some of the petals or at the margins of the fascicles; filaments connate for up to 0.6 mm, the longest 1.3–2 mm long; anthers 0.25–0.3 mm long; staminodes about as long as the longer stamens and with a very reduced, club-like, reddish anther, or without an anther and then sometimes very reduced. *Ovary* 3-locular; ovules 10–15 per loculus. *Style* 1.7–2.5 mm long, the basal 0.4–0.6 mm immersed; stigma 0.35–0.6 mm wide. *Fruits* 3-valvate, 2.5–3 mm long, 4–5 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds usually few, pale to medium brown. *Seeds* usually 8 or more per loculus, mostly with lateral surfaces somewhat flattened, 0.8–1.2 mm long, 0.5–0.7 mm thick; testa thin, cream or golden brown, smooth. (Figures 1D; 4D,E)

*Diagnostic features.* Single-stemmed shrub, growing in soil pockets on granite outcrops. *Flowers* 10–13 mm diam. *Outer sepals* prominently horned. *Petals* 4–5 mm long, white or pale pink. *Stamens* 28–40. *Staminodes* usually absent. *Ovary* 3-locular; ovules 10–15 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 10 Oct. 1994, A.R. Annels 4577, T.D. Macfarlane & R.W. Hearn (PERTH); 26 Nov. 1996, E.D. Middleton EDM 12 (PERTH); 8 Jan. 1997, E.D. Middleton EDM 20 A (PERTH); 25 Aug. 1997, E.D. Middleton EDM 46 (PERTH); 8 Oct. 1997, E.D. Middleton EDM 53 (PERTH); 4 Dec. 2002, B.L. Rye 221240 & R.W. Hearn (NSW, PERTH).

*Distribution and habitat.* Occurs on at least eight granite outcrops in an area with 1,000–1,300 mm annual rainfall, extending from near Weld River east to near Frankland River (Figure 9B). *Astartea granitica* is restricted to the middle-level and upper soil pockets of the outcrops where it is dominant and forms dense stands. Other taxa commonly associated with granite, such as *Verticordia plumosa*, occur nearby but tend to be excluded from the soil pockets where *A. granitica* is best established.

*Phenology.* Flowers mainly from early October to December.

*Common name.* Granite Astartea.

*Conservation status.* Priority Three under DEC Conservation Codes for Western Australian Flora; listed under *A. sp.* Mt Johnston (A.R. Annels 5645) in Smith (2012). This geographically restricted species lacks a lignotuber and is susceptible to dieback caused by *Phytophthora*.

*Etymology.* The epithet refers to the habitat of this species.

*Affinities.* This species and *A. middletonii* are unusual in having almost terete leaves and in their occurrence in soil pockets of granite outcrops. Both have large flowers with prominently horned sepals, but *A. middletonii* differs from *A. granitica* in having a lignotuber, with seedlings rarely produced, and a later flowering period. The two taxa apparently show a marked difference in seed and chaff colouring, although this needs confirmation, and they are geographically separated, with *A. middletonii* occurring closer to the coast and in a higher rainfall zone, south-west of the distribution of *A. granitica*. *Astartea middletonii* also tends to occur in deeper soil pockets where it grows in combination with *Taxandria*, whereas *A. granitica* is restricted to the higher, shallower pockets where it is more protected from fire and has no competition with *Taxandria*.

*Co-occurring taxa.* Having a specialised habitat on granite outcrops, this species rarely, if ever, occurs with other *Astartea* species.

*Notes.* *Astartea granitica* produces copious seedlings following fires or following the death of mature plants through drought or other factors. In soil pockets where adult plants have died, the seedlings are sometimes of two distinct sizes, with small, recently germinated seedlings as well as larger ones from the previous year. However, in soil pockets with a dense stand of mature plants, there are no seedlings. Seedlings have a pine-like growth form as on the two plants mounted on E.D. Middleton 20 A. For more detailed information on the biology of this species see Hutchinson (1997).

***Astartea laricifolia*** Schauer in W.G. Walpers, *Repert. Bot. Syst.* 2: 922 (1843). *Leptospermum laricifolium* A.Cunn. ex Schauer nom. inval. in W.G. Walpers, *Repert. Bot. Syst.* 2: 922 (1843). *Type:* 'In paludosis ad Sinum Regis Georgii III' [in swamp near King George Sound, Western Australia], 31 January 1818, A. Cunningham 81 (*lecto*: BM 000758993, *fide* B.L. Rye, *Nuytsia* 16: 154 (2006); *?isolecto*: BM 000758994, 000758995, PERTH 07010834).

*Astartea* sp. wing tips (M.E. Trudgen 12044), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

*Illustration.* J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *Astartea* sp. wing tips (M.E. Trudgen 12044)].

*Shrub* 1.5–5 m high, usually with a lignotuber in most situations but some plants or populations non-lignotuberous; young (actively growing) stems widely and delicately winged, golden brown to red-brown between the wings; wings expanded at the top of each internode to a recurved flange/protrusion 0.5–1.2 mm wide, pale grey and often brown- or red-tinged to golden brown; older stems with a pale grey, outer layer often with small black dots, eventually peeling off to reveal a brown underlayer. *Leaves* widely spreading, straight or somewhat curved, mostly in fascicles. *Petioles* 0.3–0.9 mm long, poorly or moderately well defined, rarely apparently absent. *Leaf blades* linear in outline, with adaxial surface flat or furrowed, 5–10.5 mm long, 0.35–0.5 mm wide, 0.35–0.5 mm thick, acute or obtuse, relatively smooth, dotted with numerous small oil glands. *Inflorescence* of usually 4–9 pairs of flowers per branchlet or with 2 or 3 pairs in each leaf fascicle spaced along each branchlet. *Peduncles* 1–2.5 mm long. *Bracteoles* usually caducous, 0.8–1.3 mm long, 0.2–0.25 mm wide, usually rather scarious; apex hooded, obtuse or acute. *Pedicels* 2.5–5.5 mm long, distinctly longer than the peduncle. *Buds* somewhat 5-lobed. *Flowers* 5.5–8 mm diam. *Hypanthium* 1.3–1.5 mm long, 2–2.5 mm wide; adnate portion irregularly slightly rugose and with oil glands becoming obvious in fruit, green; free portion 0.4–0.7 mm long, darker and smoother, usually reddish. *Outer sepals* 0.4–1 mm long, 0.8–1.1 mm wide, smooth or dorsally ridged; scarious margin almost entire. *Petals* 1.7–2.5 mm long, white; margin usually almost entire. *Androecium* of 30–41 stamens, in fascicles of 5–11 opposite the sepals and sometimes also 1 opposite 1–4 of the petals; filaments connate for up to 0.4 mm, the longest 0.9–1.3 mm long; anthers c. 0.2 mm long; staminodes few or absent, either on the margin of a fascicle or opposite a petal, usually long and unclubbed, up to 1.5 mm long. *Ovary* 3(4)-locular; ovules 13–16 per loculus. *Style* 1.5–1.8 mm long, the basal 0.3–0.4 mm immersed; stigma 0.2–0.25 mm wide. *Fruits* 3(4)-valvate, 1.5–2 mm long, 2–3 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds golden brown or darker brown. *Seeds* commonly 1–5 per loculus, 0.6–0.7 mm long, 0.4–0.5 mm thick; testa thin, creamy to golden brown, smooth. (Figure 1E)

*Diagnostic features.* Tall shrub or small tree occurring in very damp habitats with tall vegetation; young stems prominently winged. *Flowers* 5.5–8 mm diam. *Sepals* smooth or ridged. *Petals* 1.7–2.5 mm long, white. *Stamens* 30–41. *Staminodes* usually absent. *Ovary* 3-locular; ovules 13–16 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: 18.5 km E of Walpole, track off Peaceful Bay Rd, Walpole-Nornalup National Park, 19 Jan. 1989, *A.R. Annels* 664 (PERTH); King George Sound, 1828–1829, *W. Baxter s.n.* (BM 000603454); 2.2 km S of NE corner of Yelverton Forest Block, 3 Dec. 1996, *N. Casson & T. Annels* SC 29.20 (PERTH); Brockman Highway 9 km E of Sues Rd intersection, 10 Jan. 2001, *R.J. Cranfield* 16206 (PERTH); on Meerup River, 50 m N of old track, 27 Feb. 1997, *C. Day & P. Ellery* P 74.1A (PERTH); no precise locality, *J. Drummond* [coll. 2?] n. 3 (MEL 76294); Marrinup Brook, Marrinup, 26 Feb. 1921, *C.A. Gardner* 706 (PERTH); Chester Pass, Stirling Range, 16 Jan. 1936, *C.A. Gardner s.n.* (PERTH); King George Sound, Jan. 1834, *C.A. von Huegel s.n.* (W); Bow River, Dec. 1912, *S.W. Jackson s.n.* (NSW, PERTH); 1.3 km W of Angrove Rd/Centre Rd intersection, 13 Feb. 1997, *C. McChesney & C. Day* W 35.1 (PERTH); Break Rd, 3.8 km W of Harewood Rd and 6.2 km E of Fernley Rd, 22 Jan. 2003, *B.L. Rye* 230145, *R.W. Hearn & B.G. Hammersley* (PERTH); Broke Inlet Rd, 4.6 km E of Chesapeake Rd, 23 Jan. 2003, *B.L. Rye*

230175 & R.W. Hearn (AD, BRI, PERTH); Sandalwood Rd, 3.6 km NW of turnoff into camping area and 6.4 km SE of Mettler Lake Rd in Reserve 31240, NW of Cape Riche, 7 Jan. 2010, B.L. Rye 290132 (PERTH); W across inlet from Walpole township, 13 Feb. 1994, M.E. Trudgen 12044 (PERTH); King George Sound, 1880, Webb 45 (MEL).

*Distribution and habitat.* Distributed mainly from Augusta east to near Cape Riche, also extending north to Dwellingup (Figure 10A), and possibly also occurring further east. Occurs in very damp habitats with tall vegetation, especially in deep gullies along small watercourses.

*Phenology.* Flowering is recorded from early December to early March, especially from mid-December to early February.

*Conservation status.* Not currently considered to be at risk, as it has many large populations and is known from a number of national parks and other reserves.

*Etymology.* From the Latin *larix* (larch tree) and *folium* (leaf), as this species has leaves that are slender and densely clustered like those of the larch.

*Common name.* Winged Astartea.

*Affinities.* This species is a very distinctive member of the *A. scoparia* group, differing from other members of that group in having the pedicels always distinctly longer than the peduncles. Internodes of rapidly growing shoots are 4-winged, usually very prominently so, and the leaves are always in fascicles. The prominently winged stems distinguish *A. laricifolia* from all other members of the genus, although some relatively dormant specimens have much less obvious wings.

*Astartea laricifolia* is also notable in having an exceptionally strong odour of aromatic oils when its leaves are crushed. These chemicals are likely to include myrtenal and myrtenol, both of which discourage insects and so might give the species some protection against foragers (see Lowe *et al.* 2005).

*Co-occurring taxa.* Although *A. laricifolia* has been recorded growing with many other *Astartea* species, its tendency to occupy a distinct habitat, always with tall, dense vegetation, means that it frequently occurs alone. Another species found in tall vegetation is *A. leptophylla*, but it occurs on river banks that are subject to destructive flooding whereas *A. laricifolia* occurs in more stable habitats. Both *A. laricifolia* (M. Koch 2125) and *A. leptophylla* (type specimen) have been recorded from Preston River. A collection from Meerup River (C. Day & P. Ellery P 74.1) has one piece (A) definitely of *A. laricifolia* with prominently winged stems and two others (B) similar to *A. leptophylla* in their stems but still with short peduncles like *A. laricifolia*; the latter two might possibly be from a hybrid.

*Notes.* Very prominently winged stems similar to those of *A. laricifolia* occur in the closely related genus *Hypocalymma*, in *H. cordifolium*. *Hypocalymma cordifolium* has a similar distribution, being concentrated along the south coast in damp habitats. Presumably these environmental similarities have led to the stem morphology convergence between the two species, although they differ considerably in most other characters.

The only known specimen of *A. laricifolia* from the Stirling Range (C.A. Gardner s.n., 16 Jan. 1936) has c. 40 stamens per flower including one opposite most of the petals. No other specimens have been found so far with as many stamens opposite the petals, but some flowers with one or two antipetalous stamens are present on a range of specimens.

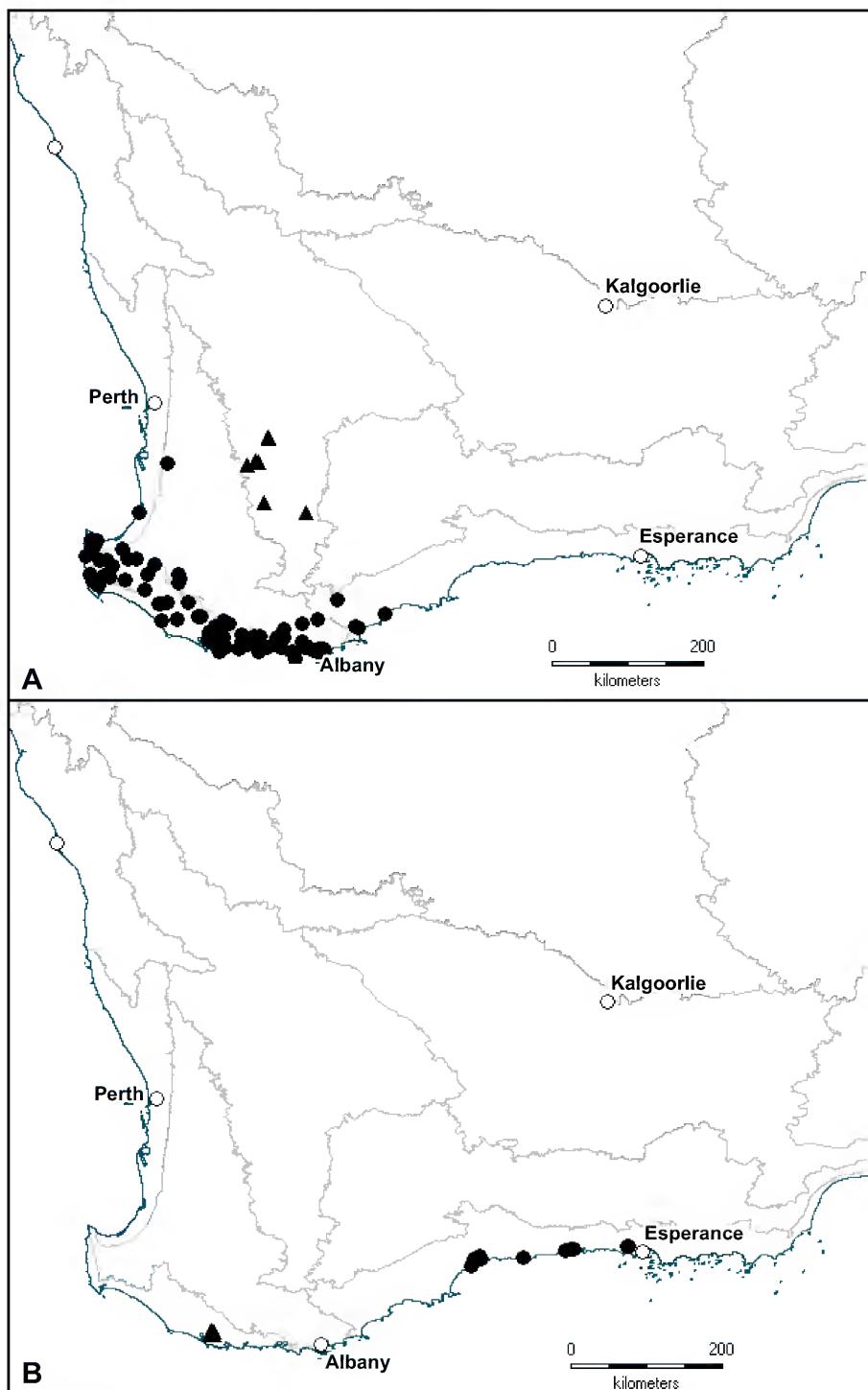


Figure 10. Distributions of *Astartea* species. A – *A. laricifolia* (●), *A. muricata* (▲); B – *A. middletonii* (▲), *A. reticulata* (●).

**Astartea leptophylla** Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 113 (1844). *Type:* ‘In umbrosis ad ripam fluvii Preston (prov. Wellington), solo limoso’ [shady river bank, muddy site, Preston River, Western Australia], 1 January 1840, L. Preiss (Herb. Preiss No.) 156 (*holo:* LD; *iso:* MEL 2147398).

*Astartea* sp. rivers (K.R. Newbey 1740), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West 2:* 688 (2002).

*Illustration.* J. Wheeler, N. Marchant & M. Lewington, *Fl. South West 2:* 688 (2002) [as *Astartea* sp. rivers (K.R. Newbey 1740)].

*Shrub* 2–5 m high, without a lignotuber but frequently reproducing by layering, with trunk commonly blackened and often with debris or lichens; young (actively growing) stems 4-ridged or very narrowly 4-winged at first; older stems with a smooth, grey, outer layer eventually peeling off to reveal a darker, grey-brown layer. *Leaves* antrorse to widely spreading, mostly in fascicles, straight or somewhat curved. *Petioles* 0.5–2 mm long, poorly differentiated and often appearing to be absent. *Leaf blades* linear in outline, with adaxial surface flat or furrowed, 8–16 mm long, 0.5–0.8 mm wide, 0.4–0.5 mm thick, acute or obtuse, relatively smooth. *Inflorescence* of usually several pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 2–4.5 mm long. *Bracteoles* 1–1.7 mm long, 0.25–0.35 mm wide; apex hooded, obtuse, sometimes with a slight dorsal point. *Pedicels* 2–4 mm long. *Buds* somewhat 5-lobed. *Flowers* 6.5–9 mm diam. *Hypanthium* 1.6–2 mm long, 2.5–3 mm wide; adnate portion irregularly slightly rugose and with numerous oil glands; free portion 0.5–0.8 mm long. *Outer sepals* 0.6–1 mm long, 0.9–1.3 mm wide, smooth or slightly ridged dorsally; scarious margin almost entire. *Petals* 2.3–3 mm long, white; margin almost entire to denticulate. *Androecium* usually of 28–40 stamens, in fascicles of 4–10 opposite the sepals; filaments connate for up to 0.4 mm, the longest 1–1.3 mm long; anthers 0.2–0.25 mm long; staminodes few or absent, usually long and unclubbed. *Ovary* 3-locular; ovules 9–13 per loculus. *Style* 1–1.5 mm long, the basal 0.4–0.5 mm immersed; stigma 0.25–0.3 mm wide. *Fruits* 3-valvate, 1.5–1.7 mm long, 2.3–2.5 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds medium brown or reddish brown. *Seeds* usually several per loculus, 0.7–1.1 mm long, 0.35–0.6 mm thick; testa thin, cream or golden brown, smooth.

*Diagnostic features.* Tall shrub or small tree, single-stemmed or layering, occurring on river banks. *Flowers* 6.5–9 mm diam. *Sepals* smooth or slightly ridged. *Petals* 2.3–3 mm long, white. *Stamens* 28–40. *Staminodes* usually absent. *Ovary* 3-locular; ovules 9–13 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: Blackwood River, J. Forrest s.n. (MEL 76235); banks of Canning River, Roleystone, 23 Dec. 1967, G. Heinsohn 158 (PERTH); St Johns Brook, N of Barrabup Pool, NW of Nannup, 26 Dec. 2000, M. Hislop 2178 (PERTH); Hay River, 2 Dec. 1994, G. Janicke 268 (PERTH); Alexandra Bridge, where Brockman Hwy crosses Blackwood River, 6 Jan. 1985, R.A. Kilgour 523 (MEL, PERTH ex MEL); Wheatley’s Mill, 25 Jan. 1918, G.E. Lane-Poole s.n. (PERTH); Blackwood River c. 2 miles [3 km] W of junction with Rosa Brook, E of Karridale, 3 Jan. 1971, B.R. Maslin 1611 (NSW, PERTH); N bank of river, Margaret River, off Carters Rd, 12 Jan. 2005, A. Matei R 205 (PERTH); Warren River, Manjimup, 21 Mar. 1996, J. Moore s.n. (PERTH); valleys of the Serpentine River, Darling Range, 1 Dec. 1877, F. Mueller s.n. (MEL 75938); Tone River, c. 0.1 km E of Tone River Bridge on Mordalup Rd, 21 Jan. 2003, B.L. Rye 230105 & R.W. Hearn (PERTH); Fernhook Falls at Beardmore Rd crossing of Deep River, 23 Jan. 2003, B.L. Rye 230162 & R.W. Hearn (AD, BRI, PERTH); Fernley Rd at bridge over Styx River, 22 Jan. 2003, B.L. Rye 230146 & R.W. Hearn (PERTH); creekline below Mundaring Weir, where main road

crosses it, 22 Mar. 1992, *M.E. Trudgen* 10755 (PERTH); Lease Rd, Donnelly River crossing, 8 Dec. 1999, *V.L. Tunsell, R.J. Cranfield & R.W. Hearn* 076 (PERTH).

*Distribution and habitat.* Occurs on the banks of rivers in near-coastal areas of the south-west, extending from Helena River near Perth to Hay River (Figure 8B). Apparently restricted to watercourses that are fast-flowing in winter, mostly occurring on unstable muddy banks. At Fernhook Falls in the Deep River, the species occurs on granite islands in the river as well as on the banks.

*Phenology.* Flowers mainly mid-December to early February.

*Conservation status.* Not currently considered to be at risk, as it has numerous populations spread over a large range.

*Etymology.* From the Greek *leptos* (thin) and *phyllus* (leaf), as this species has particularly narrow leaves.

*Common name.* River-bank *Astartea*.

*Affinities.* *Astartea leptophylla* can be confused with *A. scoparia* but differs in its habit, its usually longer, finer leaves and its higher ovule numbers. It occupies a different, more specific habitat, always occurring along the banks of major watercourses whereas *A. scoparia* is associated with swamps and minor watercourses.

*Co-occurring taxa.* The unusual habitat of this species generally isolates it from other *Astartea* species. See the note under *A. laricifolia* regarding the possible occurrence of that species with *A. leptophylla*. Another species *A. leptophylla* might occasionally grow near *A. scoparia*. Although no instances of co-occurrence of the two species have been documented, a few herbarium specimens that appear to have somewhat intermediate leaves are difficult to place with certainty.

*Notes.* *Astartea leptophylla* seems to be the tallest species of *Astartea*, rivalled only by *A. laricifolia*. Both taxa are restricted to particularly damp habitats with tall vegetation.

#### ***Astartea middletonii* Rye, sp. nov.**

*Typus:* D'Entrecasteaux National Park, Western Australia [precise locality withheld for conservation reasons], 12 November 1997, *E.D. Middleton* 78 (*holo*: PERTH 04575806; *iso*: CANB, MEL).

*Astartea* sp. Pingerup rock (E.D. Middleton 78), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

*Shrub* 1–2.5 m tall, producing multiple stems from a lignotuber; young (actively growing) stems 4-ridged at first; older stems with a smooth, shiny, grey outer layer peeling off to reveal a darker grey-brown layer. *Leaves* antrorse to widely spreading, tending to be directed upwards on horizontal stems (i.e. all appearing to be on top of stem), mostly in fascicles, almost straight to distinctly curved. *Petioles* 0.8–1.5 mm long, usually poorly defined. *Leaf blades* linear in outline, almost terete towards apex but somewhat flattened on adaxial surface or with an adaxial groove towards the base, 10–15 mm long, 0.5–0.6 mm diam., acute or mucronulate. *Inflorescence* usually of several to many pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 4–8 mm long. *Bracteoles* 3.5–5.5 mm

long, 2.1–3 mm wide, reddish with pale scarious margins 1.5–2 mm wide, with keel produced into stout terminal horn; horn recurved distally, 1.3–1.9 mm long. *Pedicels* 1.5–3.5 mm long. *Buds* with 5 prominent, erect, pink or reddish horns and often deep pink petals. *Flowers* 11–15 mm diam. *Hypanthium* 2–3 mm long, 3–5 mm diam.; adnate portion irregularly rugose and with numerous oil glands, scarcely ribbed; free portion 0.6–1 mm long. *Outer sepals* 1–1.6 mm long, 1.9–2.2 mm wide, prominently horned, the herbaceous portions reddish; scarious margin broad, petal-like, almost entire to distinctly denticulate; horn broad-based, distally incurved, 0.6–1.4 mm long. *Petals* 4–6 mm long, white or pale pink; margin minutely crenulate to distinctly denticulate. *Androecium* of 37–60 stamens, in fascicles of 6–13 opposite the sepals, sometimes also with solitary (very rarely 2) stamens opposite some of the petals, sometimes also with a few staminodes; filaments connate for up to 0.6 mm, the longest 1.7–2.1 mm long; anthers 0.25–0.3 mm long; staminodes (when present) usually about as long as the longest stamens and with a small terminal club. *Ovary* 3-locular; ovules 13–15 per loculus. *Style* 1.6–2.3 mm long, the basal c. 0.7 mm immersed; stigma c. 0.3 mm wide. *Fruits* 3-valvate, 1.8–2 mm long, 3.3–4 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds deep red. *Seeds* not seen fully mature, several or more per loculus, mostly with lateral surfaces somewhat flattened, 0.7–0.8 mm long, 0.4–0.5 mm thick; testa thin, white with a red patch on the inner margin above the inner protrusion, smooth.

*Diagnostic features.* Lignotuberous shrub growing in soil pockets on granite outcrops. *Flowers* 11–15 mm diam. *Outer sepals* prominently horned. *Petals* 4–6 mm long, white or pale pink. *Stamens* 37–60. *Staminodes* few or absent. *Ovary* 3-locular; ovules 13–15 per loculus. *Seeds* with a thin testa, partially red, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 16 Dec. 1999, E.D. Middleton TEDW 115 (PERTH); 18 Dec. 1999, E.D. Middleton TEDW 124 (PERTH); 18 Dec. 1999, E.D. Middleton TEDW 126 (PERTH); 18 Dec. 1999, E.D. Middleton TEDW 127 (PERTH); 4 Dec. 2002, B.L. Rye 221235 & R.W. Hearn (PERTH); 23 Jan. 2003, B.L. Rye 230163 & R.W. Hearn (AD, NSW, PERTH); 3 Dec. 1997, S. Watkin 387 (PERTH), 388 (PERTH).

*Distribution and habitat.* Restricted to a few granite outcrops in a small area north of Broke Inlet with an annual rainfall of c. 1,400 mm (Figure 10B). Occurs in soil pockets on large outcrops in nutrient-rich, sandy soil over granite. It often grows intermixed with *Taxandria linearifolia* in the deeper soil pockets. Other species occurring in the same or shallower pockets include *Acacia myrtifolia*, *Verticordia plumosa* and *Pimelea imbricata*. In addition to these natural populations, a few specimens (e.g. E.D. Middleton TEDW 124) have been collected from disturbed roadside locations in more sandy localities below the granite rocks, possibly transferred there by vehicles.

*Phenology.* Flowers recorded from mid-November to January.

*Conservation status.* Priority Two under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Pingerup rock (E.D. Middleton 78) in Smith (2012). This species has a lignotuber and rarely produces seedlings. It is very restricted in distribution, its total range extending for less than 10 km on scattered granite outcrops that mostly have large populations surrounded by dense, tall, forest undergrowth, making access to them difficult.

*Etymology.* This species is named after its discoverer, Ted Middleton, who has surveyed and collected it from throughout its known range.

*Affinities.* Somewhat intermediate in morphology between *A. granitica* and *A. schaueri*, resembling the former more closely in its habitat, height, stamen numbers and ovule numbers, but resembling the latter more in having a lignotuber and in its apparently more reddish seeds. See the notes under those two species. All three species are similar in having large bracteoles and prominently horned sepals.

*Co-occurring taxa.* Having a specialised habitat on granite outcrops, this species rarely occurs with other *Astartea* species.

*Notes.* *Astartea middletonii* has the largest flowers in the genus and tends to produce the most numerous stamens. As with other species, however, the flower size is very variable and can be reduced to less than 11 mm diam. in very water-stressed plants. The length of the sepal horn is also very variable, with long-horned and short-horned plants recorded from the same populations. One specimen with very numerous stamens (E.D. Middleton TEDW 116) occasionally has two stamens, sometimes one long and one short, opposite one of the petals.

This species apparently has poor seed set in comparison with other *Astartea* species, mainly through the abortion of whole fruits, with the plants drying off rapidly after flowering and a majority of the flowers failing to develop into fruits. Where fruits are successfully formed, however, the proportion of ovules producing seeds appears to be reasonably high. In January 2003, attempts to collect fully developed fruits from one of the populations were barely successful, although this may have been due in part to it having been a particularly dry year. Ted Middleton (pers. comm.) has never seen seedlings of this species and has been unable to grow it from seed, in contrast with *A. granitica*, which produces copious seeds and seedlings. However, the occasional occurrence of specimens along disturbed roadsides suggests that *A. middletonii* is successfully reproducing by seed even if not as prolifically as the other species. The few immature seeds examined resembled the immature seeds of *A. schaueri* in colouration and would appear therefore likely to become more red-spotted at maturity as in that species.

#### ***Astartea montana* Rye, sp. nov.**

*Typus:* Stirling Range Drive, 13.7 km west of Chester Pass Road, Western Australia, 6 December 2002, B.L. Rye 221263 (*holo*: PERTH 06585787; *iso*: CANB, K, MEL).

*Astartea* sp. staminodes (A. Strid 21584), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

*Shrub* 0.5–1 m high, producing multiple stems from a lignotuber; young (actively growing) stems red-brown, with narrow ridges or wings up to 0.2 mm wide; older stems deep red-brown then becoming pale grey, sometimes developing opposite-decussate stripes of pale grey epidermis (each stripe extending from the base of a leaf down to the next node) alternating with reddish brown stripes but tending to be more uniform. *Leaves* mostly in fascicles, slightly curved to straight. *Petioles* 0.7–1.2 mm long, poorly defined. *Leaf blades* narrowly or very narrowly obovate from side view, 4–7.5 mm long, 0.4–1 mm wide, 0.5–0.8 mm thick, obtuse. *Inflorescence* of several to many pairs of flowers spread along the branchlets. *Peduncles* 2.5–4 mm long. *Bracteoles* 1.8–3.5 mm long, 0.35–0.6 mm wide, sometimes dark reddish, the hooded apex sometimes with a small dorsal point up to 0.2 mm long; scarious margins entire. *Pedicels* 1.3–2.5 mm long. *Buds* with apex fairly flat to somewhat 5-lobed. *Flowers* (6–)7–10 mm diam. *Hypanthium* 1.3–2 mm long, 2–2.6 mm wide; adnate portion prominently reticulate-pitted; free portion 0.4–0.6 mm long. *Outer sepals* 0.9–1.2 mm long, 1.5–1.8 mm wide, dorsally

smooth to very ridged; scarious margin entire. *Petals* 2.5–4 mm long, almost white to medium pink, usually pale pink; margin entire or almost so. *Androecium* of 21–35 stamens and up to 10 staminodes, with 3–8 stamens per fascicle and often also 1 stamen opposite 1–5 petals, the fascicles and solitary stamens often united into a continuous arc or circle of filaments; filaments connate for up to 0.5 mm, the longest 1.1–1.5 mm long; anthers c. 0.25 mm long; staminodes commonly 2 per fascicle with one on each margin of fascicle, sometimes reduced to 1 or absent from some fascicles (rarely replaced by a long stamen with a very slender filament but normal-sized anther), rarely also 1 opposite a petal, either attenuate or with a very reduced sterile anther forming a small club, distinctly longer than the stamens, up to 2.6 mm long, often twisted. *Ovary* 3-locular; ovules 8–12 per loculus. *Style* 1.6–2.1 mm long, the basal 0.4–0.7 mm immersed; stigma up to c. 0.3 mm wide. *Fruits* 3-valvate, c. 2 mm long, c. 3 mm diam.; hypanthium somewhat 3-lobed; abortive ovules/seeds dark red-brown. *Seeds* up to 5 per loculus, 0.75–1.1 mm long, 0.4–0.6 mm thick; testa thin, with red markings, smooth. (Figure 3D–F)

*Diagnostic features.* Lignotuberous shrub occurring in rocky sites. *Flowers* 6–10 mm diam.; hypanthium reticulate-pitted. *Outer sepals* smooth to very ridged. *Petals* 2.5–4 mm long, almost white to medium pink. *Stamens* 21–35. *Staminodes* up to 10. *Ovary* 3-locular; ovules 8–12 per loculus. *Seeds* with a thin testa, mottled, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: 15 miles [24 km] from Chester Pass Rd along Stirling Range Drive towards Red Gum Pass, 23 Oct. 1968, E.M. Canning 68/6650 (PERTH); Bluff Knoll, massif, 23 Dec. 1979, H.E.M. Dobson 79014 (PERTH); 1848–1849, J. Drummond coll. 5, n. 125 (K, NSW, PERTH); lookout S of Mt Gog, Stirling Range Drive, 24 km from Chester Pass Rd, 23 Oct. 1991, W. Greuter 23160 (PERTH); walk trail along E shoulder of Mt Trio, 29 Dec. 2001, M. Hislop 2523 (PERTH); 7 km N along Chester Pass Rd from junction of Stirling Range Drive, 25 Oct. 1985, N. Hoyle 1254 (PERTH); base of Toll Peak, 22 Nov. 1979, G.J. Keighery 2595 (PERTH); ascent on NW slope of Bluff Knoll, 12 Dec. 1982, K.H. Rechinger 60413 (PERTH); Bluff Knoll Peak, 14 Feb. 1988, A. Rose 1007 (PERTH); Bluff Knoll walk track, at saddle between Bluff Knoll and Coyanarup Peak, 30 Dec. 1991, A. Rose 1111 (PERTH); lookout S of Mt Gog on Stirling Range Drive, 24 km W of Chester Pass Rd and 17 km E of Red Gum Pass, 6 Dec. 2002, B.L. Rye 221264 (PERTH); Mondurup Peak, steep ravine on northern side, 24 Nov. 1982, A. Strid 21551 (PERTH); by Stirling Range Drive, N of Toolbrunup Peak, 25 Nov. 1982, A. Strid 21584 (PERTH); near Bluff Knoll car park, 20 Mar. 1976, M.E. & M.E. Trudgen 1643 (AD, BRI, PERTH); Mt Trio eastern peak, W from road, 29 Dec. 1988, R.T. Wills 926 (PERTH).

*Distribution and habitat.* Occurs mainly in Stirling Range National Park, recorded from a number of peaks extending from Mondurup Peak east to Bluff Knoll, and from swampy areas between the peaks (Figure 9B). It occurs in rocky soil, variously recorded as having laterite, quartzite or sandstone. An isolated population in the Manypeaks area needs further study.

*Phenology.* Flowers recorded mainly from late October to early January, but also recorded until late March. Mature fruits and seeds seen on only two specimens (*A. Rose* 1007 & *M.E. & M.E. Trudgen* 1643).

*Common name.* Stirling Range Astartea.

*Conservation status.* Not currently considered to be at risk. Although it has a fairly restricted distribution, nearly all its known populations are protected within a large national park.

**Etymology.** From the Latin *montanus* (pertaining to mountains), this species being largely restricted to the Stirling Range, which includes the highest peaks of south-western Australia. *Astartea montana* occurs mainly, but not entirely, at higher altitudes than all other members of the genus.

**Affinities.** This species has been confused with *A. fascicularis* because both species have large flowers with staminodes commonly produced on each side of the stamen fascicles, but the two taxa do not appear to be particularly closely related, and they show significant differences in their ovule numbers and seed colouration. The white inner protrusion on the seed is very prominent in *A. montana* and strongly contrasts with the red-mottled testa of the seed body.

*Astartea montana* is most similar to species that have a reticulate-pitted hypanthium, such as *A. glomerulosa*. Some specimens of this group that are lignotuberous like *A. montana* have been given the informal name *A. sp. southern ranges* (T.E.H. Aplin 2108); these lack staminodes and occur predominantly in lower altitudes south of the Stirling Range. Further studies are needed to determine the status of this unnamed taxon.

**Co-occurring taxa.** This species has not been recorded growing with any other *Astartea* species.

**Notes.** The appearance of the androecium is quite variable in *A. montana*. The stamens are sometimes arranged, as in *M. Hislop* 2523, in a complete ring (rather than discrete antisepalous fascicles or free stamens), although still united higher opposite the sepals. The specimen with the largest number of stamens, *M.E. & M.E. Trudgen* 1643, has a solitary stamen opposite each petal and usually only one staminode at the margin of each sepal. Two other extremes are specimens either with very few staminodes or with 10 staminodes and relatively few stamens. The staminodes are very obvious as they are up to twice as long as the stamens.

***Astartea muricata* Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersburg* 10: 334 (1852). Type:** ?Brogden [probably from the route to Albany via the Williams area, Western Australia], 1843–1844, *J. Drummond* coll. 3, n. 35 [as coll. 5, n. 25 *ex parte*] (*holo*: KW n.v., photograph PERTH 07523408; *iso*: PERTH 03852520 ex BM, 06172652 ex K].

**Shrub** 0.4–1 m tall, recorded up to 0.7 m wide, single-stemmed at base but often branching close to base, with a tap root and several horizontal main roots radiating just below the soil surface; young (actively growing) stems 4-ridged, not or scarcely winged, with numerous crown-shaped outgrowths; older stems pale grey. **Leaves** mostly in fascicles, slightly curved to straight. **Petioles** 0–0.5 mm long, absent or poorly defined. **Leaf blades** narrowly or very narrowly obovate from side view, 3–8 mm long, 0.5–0.8 mm wide, 0.5–0.9 mm thick, obtuse, often with crown-shaped outgrowths. **Inflorescence** mostly with 1 to several pairs or clusters of flowers on each lateral branchlet along each main branchlet. **Peduncles** 2–5 mm long, 1–3-flowered (usually 1-flowered), occasionally with 2 peduncles in a single axil, much longer than the pedicel; secondary peduncles present only on the younger lateral flowers of 2- or 3-flowered peduncles, commonly 0.5–0.8 mm long. **Bracteoles** 0.6–1 mm long, 0.3–0.4 mm wide, the apex hooded; scarious margins narrow, entire; point ± absent. **Pedicels** 0.5–1.5 mm long. **Flowers** 5.5–8 mm diam. **Hypanthium** 1.3–1.8 mm long, 1.6–2.5 mm diam., with slight to prominent ribs opposite the sepals and sometimes also opposite the petals; adnate portion somewhat rugose and gland-dotted; free portion 0.3–0.5 mm long. **Outer sepals** depressed-semicircular, 0.4–0.6 mm long, 0.9–1.5 mm wide, reddish; scarious margin narrow, clear-translucent, entire, fairly smooth or somewhat ridged dorsally. **Petals** pale pink or white, very broadly obovate, 2.2–3 mm long; margin entire. **Androecium** of 22–35 stamens, in fascicles of 3–10 stamens (always with 6 or more stamens

present in some of the fascicles) opposite the sepals, rarely also with a solitary stamen or a fascicle opposite one of the petals in partially 6-merous flowers; filaments connate for up to 0.5 mm, the longest 0.8–1.4 mm long; anthers c. 0.25 mm long; staminodes absent or rare. *Ovary* 3(4)-locular; ovules 10–16 per loculus. *Style* 1–1.6 mm long, the basal 0.4–0.5 mm immersed; stigma 0.25–0.35 mm wide. *Fruits* 1.4–1.6 mm long, 2.3–3.7 mm diam.; hypanthium hemispheric; undeveloped ovules/ seeds dark red-brown. *Seeds* probably several to over 10 per loculus, often somewhat compressed bilaterally, 0.6–0.8 mm long, 0.35–0.5 mm thick; testa relatively thick, colliculate or reticulate-pitted, dark red-brown. (Figure 2A)

*Diagnostic features.* Single-stemmed or basally branched shrub associated with watercourses and winter-wet depressions; young stems muricate. *Flowers* 5.5–8 mm diam. *Sepals* smooth or somewhat ridged. *Petals* 2.2–3 mm long, pale pink or white. *Stamens* 22–35. *Staminodes* usually absent. *Ovary* 3-locular; ovules 10–16 per loculus. *Seeds* with a thick testa, dark red-brown, colliculate or reticulate-pitted.

*Selected specimens examined.* WESTERN AUSTRALIA: N boundary of Wishbone Reserve, Dumbleyung Shire, 3 Oct. 1995, E.M. Bennett & C. Day WB opp 60 (PERTH); 10.5 km S of Hotham River, private property adjacent to Great Southern Hwy, 28 Oct. 1995, D. Box 10 (PERTH); 1 km W of Aldersyde, 21 Oct. 1983, R.J. Cranfield 4506 (PERTH); ‘Swan River, 1848’ [possibly coll. 4: 52, collected in 1846–1847], J. Drummond 52 (PERTH); J. Drummond s.n. (MEL 73189, 76201, 76440, 76295); near Hotham River, Popanyinning, 5 Dec. 1922, C.A. Gardner 1876 p.p. (PERTH); Arthur River crossing 100 m W of the turnoff into Piesseville Rd from Piesseville–Tarwonga–Ballagin road, NW of Wagin, 21 Jan. 2005, F. & J. Hort 2497 (AD, MEL, NSW, PERTH); Brookton–Queda [Kweda] road, 1.2 km W of Aldersyde Rd, 6 Dec. 2002, B.L. Rye 221266 (CANB, DNA, PERTH).

*Distribution and habitat.* Known from an inland area bounded by Aldersyde, the Hotham River and Wishbone Reserve, near Dumbleyung (Figure 10A). Recorded from the banks of rivers and other damp habitats.

*Phenology.* Flowers recorded late September to early December. Fruits recorded late October to December.

*Common name.* Inland Astartea.

*Chromosome number.* Rye (1979) recorded the chromosome number of  $2n = 44$  [as *A. clavulata*]. The voucher specimen, B.L. Rye 76035, was cultivated at Kings Park and is of unknown origin. Its identification is not certain although it is clearly a member of the *A. aspera* group. It has seeds with a uniformly dark red, shallowly pitted testa, peduncles longer than the pedicels, and large stamen and ovule numbers suggestive of *A. muricata*.

*Conservation status.* Not currently considered to be at risk; it has a known range c. 120 km long and one population is in a nature reserve. A more vulnerable population near Aldersyde has many plants at varied stages of development scattered along a roadside drain for c. 200 m. It is not known how many populations occur along the Hotham River.

*Etymology.* From the Latin *murex* (a shellfish with a rough-textured shell), referring to the texture of the young stems, which are always densely covered by star-like protrusions.

*Type information.* The type of *A. muricata* is cited by Bailey (1991) as being number 25 from Drummond’s

supplement to his Fifth Collection (5S: 25), as Turzcaninow (1852) cited it as 'Drum. V, n. 25, ex parte'. In the same publication, Turcaninow published the names *Harmogia parviflora* Turcz. based on 'Drum. V, n. 25' and *Harmogia leptophylla* Turcz. based on 'Drum. V, n. 35, ex parte'. It appears that the correct number for the type of *A. muricata* is number 35 from Drummond's Third Collection, as material of 3: 35 matches the protologue very well but no material of *Astartea* has been found under 5S: 25. Turczaninow certainly had access to material of Drummond's Third Collection including number 35, so it seems probable there was no admixture in 5S: 25, but rather all material was of *H. parviflora*, while 3: 35 had mixed material of *Astartea* and *H. leptophylla*. Indeed, there appear to have been several consecutive numbers duplicated in the Third Collection, including 3: 38, which contained the type material of both *Harmogia serpyllifolia* Turcz. and *Scholtzia drummondii* Benth.

Drummond would have passed through the region of occurrence of *A. muricata* in mid- to late November 1843, a good time of year to have found the species in flower, while travelling south to King George Sound; he would also have returned through that region before reaching his home near Toodyay in early 1844 (see Erickson 1969).

There are also four sheets of *A. muricata* at MEL (73189, 76440, 76201, 76295) labelled as *Baeckea* and collected by James Drummond but with no date and no precise locality. All have slender leaves, multiple peduncles in a few of the axils (the peduncles up to 5 mm long) and MEL 76201 has large flowers with filaments up to 1.4 mm long. These do not appear to be part of the type collection.

*Affinities.* This species is similar to *A. aspera* in its muricate stems. It tends to have more stamens and ovules than *A. aspera* but there is considerable overlap in these characters. However, in populations of *A. aspera* that do have high stamen numbers, there are also very low numbers present, with numbers ranging from one to ten opposite each sepal having been recorded on the same plant. There may also be a difference in seed characters, but good samples of mature seeds are needed to check this possibility.

Over half of the specimens of *A. muricata* have more than one flower in some of their axils, including the type material, which has several 2-flowered peduncles and one 2-pedunculate axil. One specimen with many multi-flowered axils is R.J. Cranfield 4506; 2- or 3-flowered peduncles are fairly common on this specimen and there are also a few axils with two superposed peduncles. In 2-pedunculate axils the outer (abaxial) peduncle is shorter and later to mature (i.e. when the inner peduncle has an open flower, it still has a bud) and the lateral flowers of the main peduncle open later than the central flower. In *A. aspera* the pedicels are as long as or longer than in *A. muricata* but the peduncles are often shorter than in *A. muricata* and are always 1-flowered.

*Co-occurring taxa.* There is no known overlap between the entirely inland distribution of this species with those of all other *Astartea* species. However, the population of *A. scoparia* that occurs the furthest inland is almost on the margin of *A. muricata*'s range.

*Notes.* An *Astartea* species recorded from Lake Coyrecup, near Katanning, as *A. fascicularis* by Lyons (1988) is likely to be a member of the *A. aspera* group, as it occurs in the gap between the known ranges of *A. aspera* and *A. muricata*. It could, however, belong to a different genus such as *Cyathostemon*. Unfortunately there is no voucher specimen lodged at PERTH.

Good fruiting material with mature seeds is still needed for *A. muricata*. In the most mature fruits examined the chaff pieces appear to be colliculate and the immature seeds very shallowly pitted, with the inner protrusion whitish.

**Astartea onycis** Rye & Trudgen, sp. nov.

*Typus*: Scott National Park, Western Australia [precise locality withheld for conservation reasons], 17 November 1982, A. Strid 21792 (*holo*: PERTH 01898116; *iso*: CANB, K, MEL, NSW).

*Astartea* sp. Scott River (D.J. Backshall 88233), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

*Illustration*. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002), as *Astartea* sp. Scott River (D.J. Backshall 88233).

*Shrub* 0.2–1.2 m tall, spindly, often very slender but up to 1 m wide, with long weeping or almost prostrate branches and long fine branchlets, single-stemmed or sometimes multi-branched at base; young (actively growing) stems reddish, scarcely winged; older stems with grey-brown epidermis. *Leaves* appressed to moderately spreading, widely spaced on young rapidly growing stems, usually mostly not in fascicles. *Petioles* 0.3–0.7 mm long, poorly defined and sometimes appearing to be absent. *Leaf blades* straight or slightly incurved, almost linear from side view, 4–12 mm long, 0.2–0.7 mm wide, 0.3–0.8 mm thick, acute, ± smooth. *Inflorescence* of 1–17 pairs or clusters of flowers per main branchlet, with several pairs in each leaf fascicle on the very short side branchlets and solitary pairs of flowers borne where the pairs of leaves are widely spaced. *Peduncles* 0.3–5 mm long. *Bracteoles* 0.5–3.5 mm long, 0.2–0.35 mm wide, usually green with reddish base and apex, the hooded apex usually with a slender dorsal horn to 0.4 mm long, usually caducous or dehiscent but sometimes persistent at anthesis. *Pedicels* 0.7–2.5 mm long. *Buds* prominently 5-horned. *Flowers* 4–7 mm diam. *Hypanthium* 1–2.5 mm long; adnate portion fairly smooth; free portion 0.3–0.4 mm long. *Outer sepals* 0.7–1.7 mm long including and 0.4–0.7 mm long excluding the very prominent horn, 0.9–1.5 mm wide, the herbaceous portions reddish; scarious margin broad, petal-like, unevenly laciniate-denticulate; horn erect, incurved, 0.9–1.5 mm long. *Petals* 1.6–2.5 mm long, white or pale pink; margin shallowly laciniate-denticulate. *Androecium* of (5–)8–14(–16) stamens, in fascicles of 2–5 opposite several (rarely all) of the sepals and solitary stamens usually opposite at least one sepal and occasionally no stamens opposite one or two of the sepals; filaments connate for up to 0.4 mm, the longest 0.4–1.1 mm long; anthers 0.25–0.4 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 3–9 per loculus. *Style* 0.8–1.5 mm long, the basal 0.3–0.4 mm immersed; stigma 0.1–0.25 mm wide. *Fruits* 3-valvate, 0.7–1.3 mm long, 1.5–2.5 mm diam.; hypanthium shallowly hemispheric-obconic, at least half the length of the fruit; undeveloped ovules/seeds usually white to pale brown but sometimes reddish. *Seeds* up to 4 per loculus, sometimes not developed in all loculi, tending to be fairly erect, reniform to ± broadly ovoid, 0.6–0.8 mm long, 0.35–0.5 mm thick; testa thin, white to golden brown, usually cream, smooth. (Figure 3G)

*Diagnostic features*. Single-stemmed or basally branched shrub occurring in winter-wet depressions. *Flowers* 4–7 mm diam. *Sepals* prominently horned. *Petals* 1.6–2.5 mm long, white or pale pink. *Stamens* 5–16. *Staminodes* usually absent. *Ovary* 3-locular; ovules 3–9 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined*. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 1988, D.J. Backshall DB 88233 (PERTH); 11 Mar. 1997, R.J. Cranfield 11059 (PERTH); 20 Jan. 1992, N. Gibson & M. Lyons 100 (PERTH); 6 Apr. 1991, N. Gibson & M. Lyons 102 (AD, BRI, HO, PERTH); 31 Dec. 1990, G.J. Keighery 13464 (PERTH); 20 Feb. 1992, G.S. McCutcheon 2457

(PERTH); 2 Jan. 1991, *C.J. Robinson* 426 (PERTH); 5 Jan. 2010, *B.L. Rye* 290111 (NSW, PERTH); 26 Jan. 2001, *J. Scott* 382 (PERTH); 17 Nov. 1982, *A. Strid* 21472 (PERTH); 9 Dec. 1978, *E. Wittwer* W 2261 (PERTH).

**Distribution and habitat.** Extends from Scott National Park south-east to D'Entrecasteaux National Park (Figure 11A). Found on pale grey sand or sandy clay over clay in seasonally wet sedgelands, mainly on the plains not far from the south coast, such as the Scott River plain. The shrub species present include a number of other myrtaceous species associated with wetlands, such as species of *Taxandria*.

**Phenology.** Flowering is recorded from late November to March, especially in December and January.

**Conservation status.** Priority Four under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Scott River (D.J. Backshall 88233) in Smith (2012). This taxon has a fairly restricted distribution but is known from several national parks or nature reserves.

**Etymology.** From the Greek *onyx* (claw), referring to the claw-shaped horn on each sepal. This species has the most prominently horned sepals in the genus.

**Common name.** Clawed *Astartea*.

**Affinities.** A distinctive species, usually easy to recognise by its very slender leaves and the very prominent horns on its sepals. It differs from *A. affinis* in its single-stemmed habit, more slender stems and leaves, and its usually more prominently horned sepals.

**Co-occurring taxa.** *Astartea onycis* does not appear to occur intermixed with other *Astartea* species very often but has been recorded (*B.L. Rye* 290113) growing close to *A. scoparia* (*B.L. Rye* 290112) at one locality.

**Notes.** This species is very variable in peduncle length, with extreme variation often on a single plant; for example *R.J. Cranfield* 11059 has peduncles varying from c. 0.3 mm where the flowers are densely clustered to 5 mm long on the flush growth. Leaf and flower sizes vary considerably, partly depending upon environmental conditions. Stamen number is very variable; the lowest numbers recorded are 5 or 6 per flower on *A. Strid* 21472, with 0–2 stamens opposite each sepal.

#### ***Astartea reticulata* Rye, sp. nov.**

**Typus:** [north-west of Esperance,] Western Australia [precise locality withheld for conservation reasons], 10 December 2003, *B.L. Rye* 231237 (*holo*: PERTH 06586147; *iso*: CANB, K, MEL).

*Astartea* sp. Hopetoun area (A.S. George 10594), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Slender shrub commonly 0.7–1.5 m tall, single-stemmed at the base or multi-branched at or near the base, sometimes with weeping flowering branches; young (actively growing) stems red-brown, with narrow wings up to 0.2 mm wide; older stems with pale grey epidermis splitting to reveal a reddish brown underlayer. Leaves erect to widely spreading, mostly in fascicles, fairly straight. Petioles 0.4–0.8 mm long. Leaf blades ± narrowly obovate from side view, 4.5–7 mm long, 0.4–0.8 mm wide, 0.5–0.8 mm

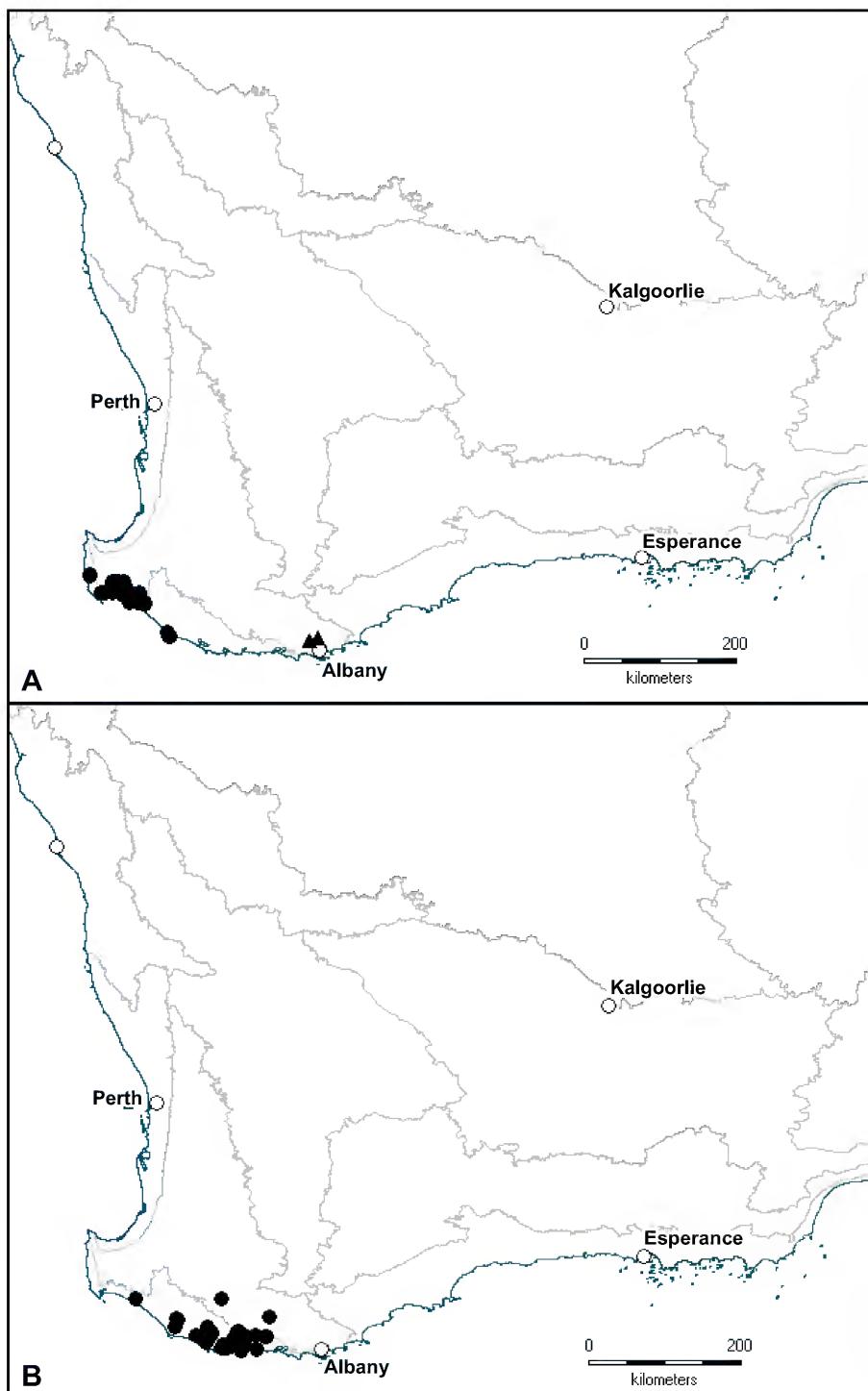


Figure 11. Distributions of *Astartea* species. A – *A. onycis* (●), *A. transversa* (▲); B – *A. schauerii* (●).

thick, acute, somewhat wrinkled-rugose. *Inflorescence* commonly of several pairs of flowers per main branchlet or on each small lateral branchlet. *Peduncles* 3–4.5 mm long. *Bracteoles* 1.3–2.3 mm long, 0.25–0.45 mm wide, with a hooded apex; scarious margins broad, entire. *Pedicels* 1.2–1.5 mm long. *Buds* 5-lobed to 5-toothed. *Flowers* 6–9 mm diam. *Hypanthium* 1.5–2 mm long, up to c. 2.5 mm wide; adnate portion usually somewhat broadly 5-ribbed, somewhat rugose and gland-dotted; free portion 0.4–0.6 mm long. *Outer sepals* 0.4–0.6 mm long, 1.2–1.5 mm wide, strongly ridged or very shortly horned; scarious margin entire; horn up to 0.1 mm long. *Petals* 2.2–2.6 mm long, pale pink to white, usually with at least some pink colour; margin entire or nearly so. *Androecium* of 14–21 stamens, in fascicles of 2–5 opposite the sepals; filaments connate for up to 0.5 mm, the longest c. 1.2 mm long; anthers c. 0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 7–11 per loculus. *Style* 1.5–2 mm long, the basal 0.4–0.5 mm immersed; stigma 0.3–0.4 mm wide. *Fruits* 3-valvate, 1.2–1.7 mm long, usually 2.3–2.5 mm diam.; hypanthium 3-lobed. *Seeds* up to 4 per loculus, irregularly ovoid, 0.9–1.2 mm long, 0.35–0.45 mm wide, 0.4–0.5 mm thick; testa moderately thick, golden brown to greyish brown, with a dark reticulate pattern resulting from darkened cell margins or mottled, with the cell margins slightly raised. *Chaff pieces* dark red-brown.

*Diagnostic features.* Single-stemmed or basally branched shrub associated with winter-wet depressions. *Flowers* 6–9 mm diam. *Outer sepals* very shortly horned or strongly ridged. *Petals* 2.2–2.6 mm long, pale pink or white. *Stamens* 14–21. *Staminodes* usually absent. *Ovary* 3-locular; ovules 7–11 per loculus. *Seeds* with moderately thick testa, partially red or mottled.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 27 Feb. 2006, G.F. Craig 7083 (PERTH); 2 Dec. 1960, A.S. George 1897 (PERTH); 20 Dec. 1970, A.S. George 10594 (PERTH); 9 Dec. 2003, B.L. Rye 231228 (NSW, PERTH).

*Distribution and habitat.* Extends from west of Quoin Head in the Fitzgerald River National Park east to near Esperance (Figure 10B). Occurs in winter-wet depressions or near watercourses along the coastal plain, commonly associated with the paperbark species *Melaleuca cuticularis*.

*Phenology.* Flowers from late November to January.

*Conservation status.* Priority Three under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Hopetoun area (A.S. George 10594) in Smith (2012). Since it was listed, further populations have been located and its known range is now c. 170 km long.

*Etymology.* From the Latin *reticulatus* (net-like), referring to the ornamentation of the seeds.

*Co-occurring taxa.* *Astartea reticulata* usually occurs alone but has been recorded with *A. cicatricosa*, as noted under that species.

*Affinities.* Differs from *A. decemcostata* as noted under that species; *A. decemcostata* also tends to have less prominently horned sepals.

*Notes.* The seed testa is described here as moderately thick as it has the cell margins slightly thickened although the interior of each cell is thin as in most species of *Astartea*.

**Astartea schaueri** Rye & Trudgen, sp. nov.

*Typus:* Coalmine Beach, Walpole, Western Australia, 1 March 2006, G.J. Keighery & B.J. Keighery 737 (*holo*: PERTH 07850425; *iso*: CANB, K, MEL, NSW).

*Astartea* sp. big bracteoles (A.R. Annels 995), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

*Illustrations.* J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 686, 687 (2002) [as *Astartea* sp. big bracteoles (A.R. Annels 995)].

*Shrubs* 0.5–1.5(–2) m high, usually low and sprawling, recorded up to 2 m wide, often entangled with other shrubs, producing multiple stems from a lignotuber; young (actively growing) stems narrowly 4-winged or 4-ridged at first; older stems with a smooth, shiny, grey outer layer eventually peeling off to reveal a darker and rougher, grey-brown layer. *Leaves* mostly in fascicles, antrorse to widely spreading, mostly recurved. *Petioles* 0.6–1.2 mm long. *Leafblades* linear in outline, flattened adaxially, 4.5–8 mm long, 0.4–0.7 mm wide, 0.5–0.8 mm thick, acute, relatively smooth. *Inflorescence* usually of several to many pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 4–7 mm long. *Bracteoles* 2.4–3.5 mm long, 1–1.7 mm wide, the scarious margin broad, with keel produced into a terminal horn or point; horn recurved distally or erect, 0.4–1.1 mm long. *Pedicels* 1.5–2.5 mm long. *Buds* with 5 prominent erect horns or smaller points and often deep pink petals. *Flowers* 8–11 mm diam. *Hypanthium* 1.4–2.1 mm long, 2.5–3.5 mm diam.; adnate portion irregularly rugose or with oil glands prominent (but not reticulate-pitted), somewhat lobed but scarcely ribbed; free portion 0.4–0.7 mm long. *Outer sepals* 0.6–1.1 mm long including moderate to very prominent horn, 1.4–1.6 mm wide, the herbaceous portions reddish; scarious margin broad, petal-like, almost entire to distinctly denticulate; horn broad-based, distally incurved, 0.3–1 mm long. *Petals* 3–4 mm long, pale pink or white; margin minutely crenulate or entire. *Androecium* of 14–27 stamens, in fascicles of 2–6 opposite the sepals or occasionally with a fascicle reduced to 1 stamen; filaments connate for up to 0.7 mm, the longest 1.2–1.6 mm long; anthers 0.3–0.35 mm long; staminodes absent or rare. *Ovary* 3-locular or 2-locular (but always with 3-locular flowers also present on the same plant); ovules 6–11(12) per loculus. *Style* 1.5–1.8 mm long, the basal c. 0.5 mm immersed; stigma 0.3–0.5 mm wide. *Fruits* 3-valvate, 1.8–2 mm long, 2.5–3 mm diam.; hypanthium somewhat 3-lobed; abortive ovules/seeds deep red. *Seeds* up to 5 per loculus but sometimes only 1 or 2 per fruit, 0.9–1.2 mm long, 0.5–0.65 mm thick; testa thin, developing red markings, smooth. (Figures 3H–J; 4F–H)

*Diagnostic features.* Lignotuberous shrub growing in winter-wet depressions. *Flowers* 8–11 mm diam. *Outer sepals* prominently horned. *Petals* 3–4 mm long, pale pink or white. *Stamens* 14–27. *Staminodes* usually absent. *Ovary* 3-locular; ovules 6–12 per loculus. *Seeds* with a thin testa, mottled, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: Walpole, Crossing Block Pt 210, 20 Dec. 1989, A.R. Annels 995 (PERTH); 500 m off South Coast Hwy, 40 km N of Walpole on road to airstrip, 4 Feb. 1997, R.J. Cranfield 10929 (PERTH); Clear Hills Rd, 10.6 km S of Mount Barker-Manjimup road, 18 Jan. 1998, R. Davis 4791 (PERTH); on the N boundary of Quarrum Nature Reserve, c. 100 m E from Boat Harbour Rd, 9 Jan. 2003, B.G. Hammersley 3245 (AD, BRI, PERTH); Break Rd, 1.4 km E of Watershed Rd, 17 Jan. 2003, B.G. Hammersley 3256 (PERTH); Middle Rd, 1.4 km S of Boronia Rd, c. 13 km E of Mt Frankland, 22 Feb. 1996, R.W. Hearn ARA 5714 (PERTH); Bow River, Dec. 1912, S.W. Jackson s.n. (CANB, K, PERTH); Broke Inlet Rd, 1.6 km W of Chesapeake Rd, 23 Jan.

2003, *B.L. Rye* 230173 & *R.W Hearn* (AD, BRI, PERTH); W across inlet from Walpole township, c. 10 m from inlet, 13 Feb. 1994, *M.E. Trudgen* 12042 (PERTH); Nut Rd Lookout, c. 2.3 km N of junction with Ficifolia Rd, Walpole–Nornalup National Park, 28 Jan. 1993, *J.R. Wheeler* 3836 & *S.J. Patrick* (PERTH).

*Distribution and habitat.* Extends along the south coast from near Windy Harbour east to Quarrum Nature Reserve and near Denmark River (Figure 11B). Occurs in depressions between the more stable coastal dunes and in low-lying, seasonally damp areas. Associated species include a variety of other *Astartea* species and many other wetland species such as *Agonis juniperina*, *Beaufortia sparsa* and *Homalospermum firmum*.

*Phenology.* Flowers mainly mid-December to early February.

*Conservation status.* Not currently considered to be at risk, as it has a range c. 120 km long. It occurs in one fairly large national park and at least one nature reserve.

*Etymology.* Named in honour of the German botanist Johannes Conrad Schauer (1813–1848), who made an impressive contribution in delimiting and naming new species of *Astartea*. He also named many other Australian species of Myrtaceae and also a number of new genera.

*Co-occurring taxa.* *Astartea schaueri* rarely occurs on its own, perhaps because its habitat and range correspond with the main area of occurrence of the genus. Species that have been found growing with it include *A. arbuscula*, *A. glomerulosa*, *A. laricifolia* and *A. scoparia*. See the notes under *A. scoparia* regarding possible hybrids.

*Affinities.* *Astartea schaueri* appears to be related to two other lignotuberous species, *A. corniculata* and *A. middletonii*, all three taxa having mottled seeds and prominently horned sepals. Relatively large-flowered specimens could be confused with *A. middletonii*, which has the largest flowers in the genus. *Astartea middletonii* differs from *A. schaueri* in its granitic habitat, its longer, more terete leaves and more numerous stamens.

Smaller-flowered specimens of *A. schaueri* could be confused with *A. corniculata*, which is a smaller plant with fewer ovules and smaller leaves, flowers and fruits.

*Notes.* Although *A. schaueri* has been known informally as *A. sp. big bracteoles* (A.R. Annels 995), its bracteoles are quite variable in size, not consistently very large as in *A. granitica* and *A. middletonii*.

***Astartea scoparia*** Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 114 (1844). *Type:* ‘In solo-arenoso secundum fl. Cygnorum supra vicum Perth’ [sandy soil along Swan River near Perth, Western Australia], February and April, *L. Preiss* (Herb. Preiss No.) 150 *ex parte* (*holo*: LD; *iso*: MEL 2147397).

*Astartea* sp. Juniperina (G.J. Keighery 9558), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

*Illustrations.* N.G. Marchant, *J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane, Fl. Perth Region* 1: 381, Figure 140 (1987) [as *A. fascicularis*]; J.R. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *A. sp. Juniperina* (G.J. Keighery 9558)].

*Shrub* 1–3 m high, with a lignotuber; young (actively growing) stems red-brown, often with narrow wings up to 0.25 mm wide; older stems developing a pale grey epidermis. *Leaves* mostly in fascicles, strongly recurved to fairly straight. *Petioles* 0.4–0.8 mm long. *Leaf blades* narrowly obovate to linear from side view, 4–10 mm long, 0.4–0.6 mm wide, 0.4–0.7 mm thick, acute. *Inflorescence* usually of many well spaced pairs or clusters of flowers along the main flowering branches, the clusters consisting of several pairs of flowers on short lateral branchlets with leaf fascicles. *Peduncles* 1.5–3.5 mm long. *Bracteoles* 1–2.5 mm long, 0.25–0.4 mm wide; apex acute or hooded, sometimes with a slight dorsal subterminal point. *Pedicels* 2–4 mm long. *Buds* somewhat 5-lobed. *Flowers* 6–9 mm diam. *Hypanthium* 1.5–2 mm long, 2–2.3 mm diam.; adnate portion gland-dotted and often somewhat rugose; free portion 0.4–0.5 mm long. *Outer sepals* 0.4–1 mm long, 0.9–1.3 mm wide, smooth or slightly ridged dorsally; scarious margin entire. *Petals* 2–3 mm long, white; margin entire or nearly so. *Androecium* of usually 20–40 stamens, in fascicles of 3–11 opposite the sepals; filaments connate for up to 0.5 mm, the longest 1–1.2 mm long; anthers 0.15–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 3–8 per loculus. *Style* 1.3–1.6 mm long, the basal 0.25–0.3 mm immersed; stigma 0.25–0.35 mm wide. *Fruits* 3-valvate, 1.4–1.8 mm long, 2–2.5 mm diam.; hypanthium usually somewhat 3-lobed. *Seeds* 0.6–0.9 mm long, 0.35–0.6 mm thick; testa thin, off-white or pale brown, smooth. (Figure 1F)

*Diagnostic features.* Medium to tall, lignotuberous *shrub* associated with winter-wet depressions. *Flowers* 6–9 mm diam. *Sepals* smooth or slightly ridged. *Petals* 2–3 mm long, white. *Stamens* usually 20–40. *Staminodes* usually absent. *Ovary* 3-locular; ovules 3–8 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA: 19 km E of Walpole, Walpole–Nornalup National Park, 17 Dec. 1987, A.R. Annels 227 (PERTH); behind first dune east of where Inlet River enters Broke Inlet, 19 Dec. 1994, A.R. Annels 5236 & R.W. Hearn (PERTH); boat harbour, Denmark, 25 Feb. 1966, A. Fairall 2194 (PERTH); Torndirrup National Park, 13 Dec. 1990, N. Gibson & M. Lyons 108 (PERTH); Gnangara Pine Plantation, along Central way [Centre Way] from Gnangara Rd, 24 Nov. 1994, E.D. Kabay 1170 (PERTH); nature reserve on Great Northern Hwy just N of Rutland Rd, 8 Dec. 1994, E.D. Kabay 1241 (PERTH); Mialla Lagoon, 31 Mar. 1995, B.J. Keighery 2001 (PERTH); E side of Scott National Park, 5 Feb. 1997, G.J. Keighery 14586 (PERTH); interdunal area, Bunbury airport, 6 km SE of Bunbury on Boyanup Rd, 7 Jan. 1999, G.J. Keighery 15597 (PERTH); Collie basin, 13 Jan. 1981, J. Koch CJK 519 (PERTH); intersection of Bibbulmun track and Allen Rd, SE of Mundaring Weir, 6 Dec. 2000, K. Macey 312 (PERTH); Lake Muir, T. Muir s.n. (MEL); Boodjidup Brook, 2 Apr. 1991, C.J. Robinson 530 (PERTH); 4.8 km W along the road that turns off 1.2 km S of Regans Ford, 10 Sep. 1975, M.E. Trudgen 1437, M. Clarke & A. Travers (PERTH); next to flow line in the valley of the Southern River, at corner of Southern River Rd and Bullfinch Rd, Huntingdale, 24 Dec. 1994, M.E. Trudgen 12193 (PERTH).

*Distribution and habitat.* Grows on coastal plains and adjacent hills around the south-west coast from Moore River to Albany, extending inland to the Kojonup area (Figure 12A). It occurs mainly in sandy, peaty soils in seasonally wet flats or depressions, sometimes dominated by *Melaleuca preissiana* or *Banksia littoralis*, or along small watercourses.

*Phenology.* Flowers mainly from December to March, beginning in late November in the north of its range and tending to flower later in the south, with occasional records at other times.

*Conservation status.* Not currently considered to be at risk; this is the most widespread of all *Astartea* species and is protected in several national parks as well as many nature reserves.

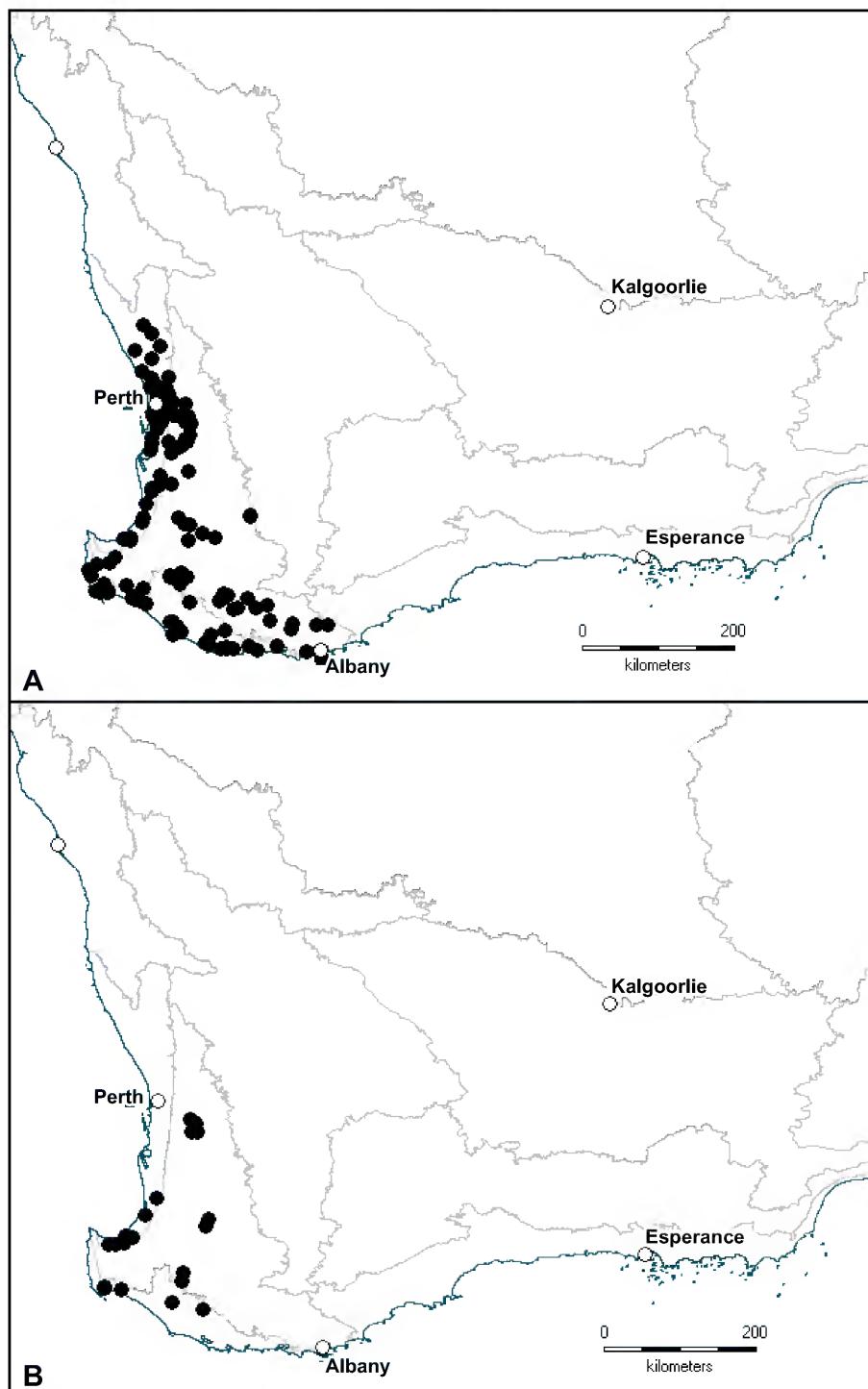


Figure 12. Distributions of *Astartea* species. A – *A. scoparia* (●); B – *A. zephyra* (●).

*Etymology.* From the Latin *scoparius* (thin twigs), in reference to its broom-like habit.

*Common name.* Common Astartea.

*Affinities.* Probably closely related to *A. leptophylla*, a riverine species with a different habit, lacking a lignotuber, and usually with longer, finer leaves. Another relative, *A. zephyra*, differs in its usually fewer stamens and ovules, and its functionally 1- or 2-locular ovaries.

*Co-occurring taxa.* This widely distributed species has been recorded with many other *Astartea* species. *Astartea scoparia* probably hybridises with *A. schaueri*; somewhat intermediate specimens with pale pink flowers were found in a mixed population of these two species near Broke Inlet (B.L. Rye 230165–230170 & R.W. Hearn). See also the notes under *A. affinis*, *A. glomerulosa*, *A. onycis* and *A. zephyra*.

*Notes.* The type specimen of *A. scoparia* from along the Swan River has fascicles of short and distinctly recurved leaves and young stems with a delicate-looking, grey epidermis dotted with small, dark glands, matching the stems of many of the specimens from the Perth area and nearby. Many specimens from the Perth region also have strongly recurved leaves (e.g. M.E. Trudgen 10753 & 10752).

This widespread and variable species is in cultivation in Western Australia and is possibly now naturalised in eastern Australia.

**Astartea transversa** Rye, sp. nov.

*Typus:* north-north-east of Albany, Western Australia [precise locality withheld for conservation reasons], 9 May 1986, G.J. Keighery 8063 (*holo*: PERTH 00995886; *iso*: CANB).

*Astartea* sp. Millbrook (G.J. Keighery 8063), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

*Illustration.* An unpublished illustration by Sue Patrick is lodged at the DEC library.

Low dwarf or small shrub, 0.1–0.4 m high, often much broader than tall, usually widely spreading, fairly dense, often with decumbent branches, probably single-stemmed at base; young (actively growing) stems reddish, not winged; older stems with pale grey epidermis splitting irregularly to reveal a brown underlayer. Leaves often in alternating whorls of 3 but always with some opposite-decussate ones, tending to be in fascicles on the lower parts of main branchlets, on newer growth mostly not in fascicles, mostly widely spreading. Petioles 0.2–0.4 mm long, poorly or well defined. Leaf blades straight, slightly incurved, narrowly obovate in outline, 2–2.5 mm long, 0.3–0.5 mm wide, 0.4–0.6 mm thick, obtuse, usually with a distinct mucro, somewhat rugose. Inflorescence of up to 12 or more pairs or triplets of flowers per main branchlet. Peduncles usually fairly straight or somewhat recurved, 0.3–1.3 mm long. Bracteoles ± narrowly ovate, 0.5–0.7 mm long, 0.15–0.3 mm wide; scarious margins fairly narrow, entire; apex acute, with midrib terminating in a mucro. Pedicels absent or less than 0.3 mm long. Buds with a somewhat 5-toothed apex. Flowers c. 2 mm diam., slightly zygomorphic with respect to the hypanthium and gynoecium. Hypanthium with adaxial surface compressed, 0.6–0.7 mm long, 0.8–1 mm wide; adnate portion tuberculate-rugose and gland-dotted; free portion 0.2–0.3 mm long. Outer sepals 0.2–0.35 mm long, 0.3–0.5 mm wide, dorsally ridged; scarious margin minutely laciniate or entire. Petals 0.5–0.7 mm long, white or pale pink; margin somewhat irregular. Androecium of 3–5

stamens, with 1 or none opposite each sepal; filaments free, 0.2–0.3 mm long; anthers 0.15–0.2 mm long; staminodes absent. *Ovary* functionally 1-locular, with one extremely reduced abortive loculus in addition to the fertile loculus; ovules 1 or 2. *Style* often displaced towards one side of the ovary, 0.6–0.7 mm long, the base slightly immersed or not immersed; stigma up to c. 0.15 mm wide. *Fruits* indehiscent, somewhat lop-sided, largely inferior, the abaxial surface flattened and the remainder convex, c. 0.6 mm long, c. 0.7 mm wide; hypanthium rugose-tuberculate. *Seed* solitary as far as known, transversely orientated, broadly reniform, c. 0.6 mm long, c. 0.5 mm thick, with pale brown with dark reddish markings, smooth. (Figures 2B; 3K; 4I)

*Diagnostic features.* Small shrub growing in swamps. *Flowers* c. 2 mm diam. *Outer sepals* ridged. *Petals* 0.5–0.7 mm long, white or pale pink. *Stamens* 3–5. *Staminodes* absent. *Ovary* functionally 1-locular; ovules 1 or 2 per loculus. *Seed* with a thin testa, mottled, smooth.

*Selected specimens examined.* WESTERN AUSTRALIA [localities withheld for conservation reasons]: 7 Apr. 1985, E.A. Griffin 4073 (PERTH); 15 May 1986, G.J. Keighery 8398 (PERTH).

*Distribution and habitat.* Occurs north-east of Albany (Figure 11A). Recorded on grey sand or peaty black sandy clay on winter-wet flats in heath.

*Phenology.* Flowering is recorded in January and from early April to June.

*Conservation status.* Priority Two under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Millbrook (G.J. Keighery 8063) in Smith (2012). Known from a single nature reserve.

*Etymology.* From the Latin *transversus* (crosswise), referring to the unusual horizontal orientation of the seed in this species.

*Affinities.* This is one of the few species in the genus that has an indehiscent, somewhat lop-sided fruit with the style base scarcely inset. It was previously included in *A. arbuscula* because of its minute flowers with very few short stamens (never more than one opposite each sepal). However, it has a different overall appearance with the leaves much more clustered. While its leaves tend to be shorter and more club-shaped, its flowers tend to be larger, with a longer style. It also differs significantly from *A. arbuscula* in its hypanthium and fruit shape and its seed orientation, shape and colouring. In those characters it is more similar to *A. corniculata*, which may be its closest relative. *A. corniculata* differs in its horned sepals and more numerous, longer stamens and functionally 2(3)-locular ovary.

*Co-occurring taxa.* The only other *Astartea* species that has been collected in the reserve is *A. corniculata*, but the vegetation for the G.J. Keighery 8398 collection of *A. transversa* was recorded as ‘*Astartea* over heath’, suggesting that at least one larger-sized species of *Astartea* was also present.

*Notes.* This appears to be the only species of *Astartea* that commonly has leaves and flowers in whorls of three, and its average stamen number is the lowest in the genus. It also seems to be unique in that its solitary seed is always transversely orientated in the indehiscent fruit (Figure 4I). The seed is closer to reniform than in other species of *Astartea* as the inner surface is more curved and both ends are equally wide, although the end distal to the hilum is distinctly thinner than the basal end, being dorsiventrally compressed. The normal seed shape in *Astartea* is more ovoid with the distal end tapering both laterally and dorsiventrally.

A photograph of this species [as *Baeckea arbuscula*] in Hopper *et al.* (1990) demonstrates the minute size of its flowers, using a match head for scale.

**Astartea zephyra** Rye & Trudgen, sp. nov.

*Typus:* 2.5 km south of Brookton Highway on Leona Road, Western Australia, 30 December 2004, B.L. Rye 241204, F. Hort & J. Hort (*holo*: PERTH 07581661; *iso*: CANB, K, MEL, NSW).

*Astartea* sp. Gingalup (N. Gibson & M. Lyons 119), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West 2*: 687 (2002).

*Illustration:* J. Wheeler, N. Marchant & M. Lewington, *Fl. South West 2*: 687 (2002), as *Astartea* sp. Gingalup (N. Gibson & M. Lyons 119).

Slender shrub, usually erect but sometimes low and spreading, (0.2–)0.5–1.5(–2) m tall, with a lignotuber and long slender branchlets; young (actively growing) stems greenish to orange-brown, not winged; older stems with a smooth, grey outer layer shedding to reveal an orange-brown underlayer. Leaves antrorse to widely spreading, all distant or often also some of them in fascicles along the main branchlets or at the apex of the branchlets. Petioles 0.4–0.8(–1) mm long. Leaf blades linear to narrowly obovate from side view, 4–10 mm long, 0.5–1 mm wide, 0.6–0.9 mm thick, obtuse. Inflorescence usually with 1 or 2 pairs of flowers per leaf fascicle, with up to c. 20 pairs along a main branchlet. Peduncles 0.7–3 mm long. Bracteoles 0.6–0.8 mm long, c. 0.3 mm wide, ridged on the hooded apex, the herbaceous part orange-brown or reddish; scarious margins broad. Pedicels 0.3–1.5 mm long. Buds ± truncate. Flowers 3.5–5 mm diam., often slightly zygomorphic with respect to the gynoecium. Hypanthium 1.2–1.8 mm long; adnate portion 5-ridged, fairly smooth or minutely irregularly rugose-pitted, the oil glands minute and often inconspicuous; free portion 0.2–0.4 mm long. Outer sepals 0.4–0.7 mm long, 0.8–1.3 mm wide, rugose but scarcely ridged dorsally, largely herbaceous and reddish; scarious margin very narrow. Petals (1.2–)1.3–1.7 mm long, white or pale pink; margin distinctly irregular to entire. Androecium of 7–20 (often 10) stamens, in fascicles of 2–5 opposite at least two of the sepals and with solitary stamens opposite up to three sepals; anthers 0.25–0.3 mm long; filaments of fascicles connate for up to 0.3 mm, the longest 0.6–1.1 mm long; staminodes absent or rare. Ovary 2-locular but often functionally 1-locular, with adaxial loculus often smaller than the abaxial one or abortive; ovules usually 1–6 per loculus. Style often displaced towards the adaxial side of ovary, 1.2–1.5 mm long, the basal 0.1–0.2 mm immersed; stigma c. 0.15 mm wide. Fruits indehiscent, often somewhat lop-sided, 1.3–1.4 mm long, 1.4–1.6 mm wide; hypanthium longer and becoming more rounded on the abaxial edge than the adaxial one; abortive ovules/seeds dark red-brown. Seeds solitary or few per fruit, usually obliquely erect, irregularly narrowly ovoid or ovoid, 0.9–1.3 mm long, 0.4–0.5 mm thick; testa thin, cream to golden brown, smooth.

*Diagnostic features.* Lignotuberous shrub growing in winter-wet depressions. Flowers 3.5–5 mm diam. Outer sepals scarcely ridged. Petals 1.2–1.7 mm long, white or pale pink. Stamens 7–20. Staminodes usually absent. Ovary functionally 1- or 2-locular; ovules usually 1–6 per loculus. Seeds with a thin testa, uniformly coloured, smooth.

*Selected 1-locular specimens examined.* WESTERN AUSTRALIA: Mill Rd, G07164 on Donnelly River, 28 Dec. 1983, A.R. Annels 1764 (PERTH); McAlinden Rd, 3.5 km SW of Trigwell Bridge Rd, SW of Bowelling, 16 Feb. 1995, V. Crowley & J. Smith DKN 428 (PERTH); Brady State Forest,

Leona Rd, 2.45 km S of Brookton Hwy, Shire of Wandering, 15 Jan. 2004, *F. Hort & J. Hort* 2165 (PERTH); SW corner of Fish Rd Reserve, 13 km SW of Busselton, 3 Jan. 1991, *B.J. Keighery* 1991/1 (PERTH); W of Ruabon, 2.5 km along Wonnerup Rd, 3 Jan. 1991, *B.J. Keighery* 1991/2 (PERTH); Ranger Swamp, 2 km W of Benger between Harvey and Brunswick, 15 Dec. 1985, *G.J. Keighery* 8369 (PERTH); 1.8 km along Curtin Rd from Creekbend Rd, 19 Mar. 1997, *K. Kershaw & C. Day* P 97.11 (PERTH); Blackwood River, 10 Dec. 1877, *F. Mueller s.n.* (MEL 76016); Pemberton District, Jan. 1972, *F.G. Smith* 2167 (PERTH); South Western Hwy, 0.45 km N of Cosy Creek Rd intersection, 5.65 km N of Manjimup town centre, 23 Jan. 2003, *B.L. Rye* 230156 & *R.W. Hearn* (PERTH); 7.9 km SE of Kinsella Rd, on S side of Brookton Hwy, 30 Dec. 2004, *B.L. Rye* 241203, *F. Hort & J. Hort* (AD, BRI, PERTH).

*Selected 2-locular specimens examined.* WESTERN AUSTRALIA: Scott River, along margin, 29 Dec. 1957, *D.M. Churchill* s.n. (PERTH); W edge of Gingalup Swamp Nature Reserve on firebreak, 25 Oct. 1990, *N. Gibson & M. Lyons* 119 (PERTH); 2 km ENE of Mt Cuthbert, 11 Jan. 2005, *F. Hort, J. Hort & L. Boyle* 2472 (CANB, MEL, PERTH); 1 km along Molloy Island from landing towards Kudardup, 13 Feb. 1978, *G.J. Keighery* 1553 (PERTH, NSW).

*Distribution and habitat.* Extends from east of Canning Dam in the Darling Range south-west to near Augusta and south to the Pemberton area, in sandy and/or clayey soils, sometimes over ironstone or laterite, in winter-wet areas, often with *Melaleuca* open woodland or heath (Figure 12B). The western variant (see below) is recorded from the margin of a river as well as from winter-wet depressions.

*Phenology.* Flowers from late November to mid-March, especially in December and January.

*Etymology.* Named after the Greek god Zephyros, the West Wind, as this species is restricted to the western part of the distribution of its genus.

*Conservation status.* As a whole this species does not appear to be at risk at present, having a range more than 250 km long, but some of its variants may be geographically restricted.

*Co-occurring taxa.* In the far south of its range, *A. zephyra* overlaps with several species such as *A. laricifolia* and *A. onycis* but there are no records of it growing with those species. It probably does occur with *A. scoparia* in a number of sites, and it is possible that some of the variation seen within *A. zephyra* results from hybridisation with that species (see below).

*Affinities.* *Astartea zephyra* appears to differ from all or most other members of the genus in its apparent lack of susceptibility to *Callococcus* infection (see *Insect associations* section). Its closest relative might be *A. scoparia*, which has 3-locular, valvate fruits.

*Notes.* The number of functional loculi in the ovary is either one or two. In most populations, there is only one functional loculus and the somewhat lop-sided fruits are usually 1-seeded. In these populations the fruit appears to be indehiscent.

Populations in the far south-west, between the Whicker Range and Scott River, have functionally 2-locular ovaries and the multi-seeded fruits appear to be dehiscent, although they may vary in this character or be only tardily dehiscent. However, specimens from the Jarrahdale area (e.g. *F. Hort, J. Hort & L. Boyle* 2469) also have 2-locular fruits, and these are definitely dehiscent. Populations in this northern area are very variable and some specimens have much larger numbers of stamens and

ovules than normally found in *A. zephyra*, suggesting that they may have arisen by hybridisation, perhaps with *A. scoparia*. Another 2-locular specimen (*B.L. Rye 230156 & R.W. Hearn*) from near Manjimup occurs in a site with very variable specimens including some typical of *A. scoparia* and hence could be a hybrid.

Plants from the Whicher Range area need further study as a 2-locular specimen (*D. Cooper 162*) from there is atypical in having a few 2-pedunculate axils and in having more numerous ovules than are known in any other specimens of the species. Of the 1-locular specimens, *B.G. Keighery 1991/1* is atypical in having the stamens all in fascicles, often with 4 or 5 per fascicle.

Despite the high degree of variation in ovary and fruit characters in *A. zephyra*, some characters such as bracteole length are fairly consistent throughout the range of the species.

### **Presumed hybrids**

Hybridisation may be more common in *Astartea* than in most other genera of the tribe Chamaeleuciaeae. One apparent hybrid is described below because it appears to have arisen between two parent species of strikingly different appearance, giving it as distinctive an appearance as is found in most species of *Astartea*, and because it is the only presumed hybrid to have been studied in any detail.

#### ***Astartea arbuscula* × *corniculata***

Small shrub c. 0.3 m tall, dense, with multiple stems from a lignotuber up to c. 90 mm wide; young (actively growing) stems reddish, not or scarcely winged; older stems with pale grey epidermis splitting irregularly to reveal a brown underlayer. Leaves antorse to widely spreading, mostly not in fascicles, almost straight or slightly incurved. Petioles 0.3–0.5 mm long. Leaf blades narrowly or very narrowly obovate in outline, 2.5–3.5 mm long, 0.35–0.5 mm wide, 0.4–0.6 mm thick, acute or almost acute, mucronate, smooth or somewhat rugose. Inflorescence of usually 2–8 well spaced pairs of flowers per main branchlet or of 1 or several pairs clustered on side branchlets. Peduncles slightly to strongly recurved, 1.5–3 mm long. Bracteoles 0.6–0.9 mm long, c. 0.1 mm wide, rather scariosus and reddish throughout, entire; apex somewhat hooded, with midrib terminating in a short point. Pedicels 0.3–0.5 mm long. Buds with a 5-toothed apex. Flowers 3–4 mm diam. Hypanthium c. 1 mm long, c. 1.2 mm wide; adnate portion irregularly broadly ribbed opposite the sepals and slightly pitted-rugose, with minute oil glands; free portion c. 0.2 mm long. Outer sepals 0.3–0.4 mm long, 0.5–0.7 mm wide, very ridged or very shortly horned; scariosus margin fairly narrow, laciniate; horn up to 0.2 mm long. Petals 0.8–1.5 mm long, deep pink; margin irregularly laciniate. Androecium of 8–12 stamens, 1–4 opposite each of the sepals; filaments connate for up to c. 0.2 mm, the longest 0.5–0.6 mm long; anthers c. 0.2 mm long; staminodes absent. Ovary functionally 1-locular, with a very reduced, abortive adaxial loculus and a fertile abaxial loculus; ovules usually 2 or 3, rarely 4. Style 0.6–0.8 mm long, the base scarcely immersed; stigma c. 0.1 mm wide. Fruits indehiscent, somewhat lop-sided, c. 0.7 mm long, c. 1.1 mm wide. Seed 1, irregularly ovoid, 0.6–0.7 mm long, c. 0.35 mm thick, cream to golden brown, smooth.

*Diagnostic features.* Lignotuberous shrub occurring in winter-wet depressions. Flowers 3–4 mm diam. Outer sepals strongly ridged to shortly horned. Petals 0.8–1.5 mm long, deep pink. Stamens 8–12. Staminodes absent. Ovary functionally 1-locular; ovules 2–4 per loculus. Seeds with a thin testa, uniformly coloured, smooth.

*Selected specimen examined.* WESTERN AUSTRALIA [locality withheld for conservation reasons]: 14 Jan. 2003, B.G. Hammersley 3249 (CANB, MEL, PERTH).

*Distribution and habitat.* Occurs close to the coast in the Denmark–Albany area. Recorded from peaty sandy soil in winter-wet depressions with low shrubs and sedges (Figure 7A).

*Phenology.* Flowers recorded from late December to mid-January.

*Conservation status.* This taxon has been described from a single, very mature plant on a nature reserve. Being lignotuberous, this plant will probably be able to survive for many more years. However, as there is no evidence that *A. arbuscula* × *corniculata* is self-perpetuating, it cannot be given any conservation status.

At another locality closer to Albany, where there is a similar mixture of *Astartea* species, varied specimens, including one with deep pink flowers that somewhat resembled the hybrid, were collected by Ellen Hickman on 17 January 2001. No specimens from this collection have been lodged at PERTH but a similar specimen with deep pink flowers (B.L. Rye 290143) was collected from the site in 2009. These specimens tend to have larger flowers, longer leaves and larger ovule numbers than the presumed hybrid at Denmark, and might have had a different origin.

*Notes.* When Brenda Hammersley (pers. comm.) collected *A. arbuscula* × *corniculata* near Denmark in January 2001 she observed that it was very rare, with only one or possibly two plants present, and that it was growing intermixed with *A. arbuscula*. Later surveys of the site in December 2002 and January 2003 revealed that there was only one plant of *A. arbuscula* × *corniculata* present, growing close to single-stemmed dwarf plants 0.1–0.2 m high of *A. arbuscula* (B.L. Rye 221249 & 230134, R.W. Hearn & B.G. Hammersley) and distinctly taller, lignotuberous plants 0.3–0.5(–0.8) m high of *A. corniculata* (B.L. Rye 221250 & 230136, R.W. Hearn & B.G. Hammersley). All three taxa were in the low vegetation across the centre of the swamp; they were not yet in flower in early December, but from late December to mid-January *A. corniculata* produced pale or very pale pink flowers, which were much larger than the deep pink flowers of *A. arbuscula*. *Astartea arbuscula* × *corniculata* had deep pink flowers of the same colour as those of *A. arbuscula* but much more obvious because of their larger size, intermediate between the sizes of the flowers of the two putative parents.

A comparison of the presumed hybrid and the variants of its parent species that co-occur with it (Table 1) shows that *A. arbuscula* × *corniculata* resembles each parent in some characters but is intermediate between them in other characters. It resembles *A. arbuscula* in its branching pattern, lack of leaf fascicles, flower colour, functionally 1-locular ovary, indehiscent fruit and uniformly coloured seeds. Its fewer similarities to *A. corniculata* include the lignotuberous habit, peduncle length and numbers of ovules per loculus. It is intermediate in having very short horns on the sepals, and in many quantitative states such as flower size and stamen number.

**Table 1.** Comparison of the presumed *Astartea* hybrid and its parent species.

	<i>A. arbutiflora</i>	<i>A. arbutiflora × corniculata</i>	<i>A. corniculata</i>
<b>Height</b>	0.1–0.2 m	0.3 m	0.3–0.5(–0.8) m
<b>Lignotuber</b>	absent	present	present
<b>Leaf fascicles</b>	absent	absent	present
<b>Peduncle length</b>	0.5–1.5 mm	1.5–3 mm	1.5–3.5 mm
<b>Bracteole length</b>	0.3–0.45 mm	0.6–0.9 mm	1.2–2 mm
<b>Pedicel length</b>	0–0.3 mm	0.3–0.5 mm	1.3–1.8 mm
<b>Sepal horn</b>	absent	0–0.2 mm	0.4–1 mm
<b>Flower diameter</b>	1.5–2 mm	3–4 mm	(4)–4.5–6 mm
<b>Petal length</b>	0.4–0.6 mm	0.8–1.5 mm	1.7–2.5 mm
<b>Petal colour</b>	deep pink	deep pink	pale pink
<b>Stamen number</b>	5	8–12	15–20
<b>Functional loculi</b>	1	1	2
<b>Ovules per loculus</b>	1	2–4	2–5
<b>Style length</b>	0.4–0.6 mm	0.6–0.8 mm	1.2–1.6 mm
<b>Fruit</b>	inindehiscent	inindehiscent	dehiscent
<b>Seed colour</b>	uniformly pale	uniformly pale	mottled

#### Doubtful names

1. *Astartea fascicularis* var. *brachyphylla* Domin, *Vesnt. Král. České Spolecn. Nauk. Tr. Mat.-Prír.* 1921/2, 2: 83–84 (1923). Type: sand plains about Warrungup [Mt Trio, Stirling Range], Western Australia, A.A. Dorrien-Smith (*n.v.*).

Notes. The type of var. *brachyphylla* has not been examined but it probably matches either *A. montana* or the material currently housed as *A. sp.* southern ranges (T.E.H. Aplin 2108).

2. *Astartea margarethae* Trudgen ms., Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000).

Notes. No specimen has ever been attached to this name, only a note that the taxon was 2 m high and occurred on loam over laterite. It appears to have arisen by mistake, being a mis-recording of the manuscript name *Baeckea margarethae* Trudgen ms. (M. Trudgen pers. comm.).

3. *Leptospermum dubium* Spreng., *Syst. Veg.* 2: 492 (1825). Type: Nov. Holl.

Notes. Much of Sprengel's herbarium, apparently including the Myrtaceae, was acquired by Berlin (B) in 1890 and is no longer extant (Stafleu & Cowan 1985: 806). Even if there is still type material in existence, it may well be difficult to link it conclusively with this name. Although he did not see the type specimen, Schauer (1843: 115) considered *Leptospermum dubium* to be synonymous with *Baeckea affinis*. It is unclear how he came to this conclusion as the protologue of *L. dubium* is much too brief and lacking in detail to be used alone to determine the taxon's identity.

### Excluded names

As noted in the introduction, two named species that were previously included in *Astartea*, *A. ambigua* and *A. heteranthera*, have been transferred to *Cyathostemon* and another two, *A. clavifolia* and *A. intratropica* have been transferred to *Seorsus*.

The following informal names apply to species that are now considered to belong in the genus *Cyathostemon*: *A.* sp. Bungalbin Hill (K.R. Newbey 8989), *A.* sp. Esperance (A. Fairall 2431), *A.* sp. Fitzgerald (K.R. Newbey 10844), *A.* sp. Jyndabinbin Rocks (K.R. Newbey 7689), *A.* sp. Mt Dimer (C. McChesney TRL4/72) and *A.* sp. Red Hill (K.R. Newbey 8462).

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## Two new species of *Westringia* sect. *Cephalowestringia* (Lamiaceae: Westringieae) from the south-west of Western Australia

Robert W. Davis<sup>1</sup> and Peter Jobson<sup>2</sup>

<sup>1</sup>Western Australian Herbarium, Department of Environment and Conservation, Locked Bag 104,  
Bentley Delivery Centre, Western Australia 6983

<sup>2</sup>Northern Territory Herbarium, Department of Land Resource Management, P.O. Box 1120,  
Alice Springs, Northern Territory 0871

<sup>1</sup>Corresponding author, email: Robert.Davis@dec.wa.gov.au

### Abstract

Davis, R.W. & Jobson, P. Two new species of *Westringia* sect. *Cephalowestringia* (Lamiaceae: Westringieae) from the south-west of Western Australia. *Nuytsia* 23: 271–276. *Westringia fitzgeraldensis* R.W.Davis & P.Jobson and *W. ophioglossa* R.W.Davis & P.Jobson are described here as new. A modification to the existing key for *Westringia* Sm. sect. *Cephalowestringia* Kuntze is provided to account for *W. fitzgeraldensis* and *W. ophioglossa*. *Westringia fitzgeraldensis* occurs in open mallee in the Fitzgerald River National Park and *W. ophioglossa* in mallee woodlands in the northern wheat-belt. A distribution map is provided.

### Introduction

*Westringia* Sm. sect. *Cephalowestringia* Kuntze is endemic to the south-west of Western Australia. It is characterised by bracteate, pseudo-capitiate inflorescences (Guerin 2009) in contrast to sect. *Westringia*, where the inflorescences are raceme-like, with distant whorls of single flowers subtended by leaf-like bracts. Prior to Guerin's (2009) review, sect. *Cephalowestringia* consisted of two species, *W. discipulorum* S.Moore and *W. cephalantha* F.Muell. Guerin *q.v.* added three new taxa, describing the new species *W. acifolia* G.R.Guerin and *W. capitonia* G.R.Guerin, and dividing *W. cephalantha* into two varieties, var. *cephalantha* and var. *caterva* G.R.Guerin.

Many species of *Westringia* are morphologically similar and mostly distinguished by quantitative characters (Bentham 1870; Boivin 1949; Conn 1988; Guerin 2009). This is not the case with the two species described here as they both have distinctive bracts and floral lobe shapes which easily separate them from other species. The new species have only recently been discovered: *W. ophioglossa* R.W.Davis & P.Jobson was found in December 2012 by both authors while on a field trip to Wubin, 200 km north-east of Perth, and *W. fitzgeraldensis* R.W.Davis & P.Jobson was collected in 2011 by Department of Environment and Conservation (DEC) botanist Damien Rathbone during a floristic survey of the coastal catchments and ranges of the Fitzgerald River National Park.

## Methods

Measurements of vegetative parts were taken from dried specimens and floral parts from material reconstituted in hot water with a little detergent. Where possible, to maintain consistency and comparability, we have followed Guerin's (2009) taxonomic description format. In the use of terminology for indumentum we have described density, length, distribution and orientation of hairs. The distribution maps are based on PERTH specimen data.

## Taxonomy

### **Westringia ophioglossa** R.W.Davis & P.Jobson, sp. nov.

*Type:* north-north-east of Wubin, east of Maya, Western Australia [precise locality withheld for conservation reasons], 23 December 2012, R. Davis & P. Jobson RD 12247 (*holo*: PERTH 08407894, *iso*: CANB).

*Westringia* sp. Maya (R. Davis & P. Jobson RD 12235), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 11 March 2013].

Compact, perennial shrubs to 1.3 m high; branches erect, terete to sub-quadrangular towards new shoots, with moderately dense, spreading hairs to 0.1 mm long, interspersed with glandular hairs. Leaves in crowded whorls of 4, petiolate, the petioles 0.7–0.9 mm long; lamina linear, 6.5–9.5(–10) mm long, 0.9–1.3 mm wide, with margins strongly revolute obscuring abaxial surface including midrib, the adaxial surface with moderately dense, spreading hairs to 0.1 mm long. Inflorescences depressed-globose, with moderately tightly clustered bracts, bracteoles and calyces held close together but the outer bracts looser, 8–12-flowered, 5–8 mm long, 10–15 mm wide. Bracts rigid, rhombic, with distal half tightly revolute, expanded in middle portion, then tapering towards base, 2.5–3.5 mm long, 0.6–1.2 mm wide; margins not ciliate; abaxial surface with sparse, antrorse hairs 0.1–0.2 mm long concentrated near margins and proximally, underlain by very short, glandular hairs; adaxial surface with sparse, antrorse hairs 0.1–0.2 mm long concentrated near margins and distal portion, underlain by short glandular hairs; apex rounded. Bracteoles dissimilar to bracts, erect, longer than calyx tube, lanceolate, 3.4–3.8 mm long, 0.7–1.1 mm wide; margins not ciliate; abaxial surface with spreading to antrorse hairs 0.1–0.2 mm long underlain by moderately dense, short, glandular hairs; adaxial surface with occasional antrorse hairs 0.1–0.2 mm long underlain by moderately dense glandular hairs; apex attenuate, slightly recurved. Calyx 3.6–3.8 mm long, with sparse to moderately dense, often retrorse but also occasionally antrorse hairs 0.1–0.2 mm long underlain by a dense covering of glandular hairs, mostly glabrous inside with very scattered, appressed hairs on upper part of lobe; tube obconical, 0.9–1.2 mm long, the base rounded; lobes imbricate in lower half, slightly incurved, ovate, longer than tube, 2.3–2.5 mm long, 1.2–1.3 mm wide, the margins slightly concave, not ciliate, the apex acuminate. Corolla 4.2–4.4 mm long, white, with a purple spot at the centre of each lateral lobe and two purple spots at the base of the abaxial median lobe; exterior surface with sparse, retrorse hairs 0.1–0.2 mm long becoming dense in the middle portion of the tube; interior surface mostly glabrous except for a ring of dense, antrorse hairs 0.2–0.3 mm long at throat; abaxial median lobe obovate in outline, bifurcate, 2.1–2.3 mm long, 3.2–3.4 mm wide, the margin entire except at apex, the apex truncate, oblique, serrated; lateral lobes linear, 2.1–2.3 mm long, 0.9–1.1 mm wide, the margin entire, the apex bifurcate; adaxial median lobes 0.1–0.2 mm long, 0.5–0.7 mm wide, the margins entire, the apices rounded. Fertile stamens with filaments inserted 1.8–1.9 mm from base of corolla tube, 1.7–1.9 mm long, with sparse, spreading hairs, their anthers basifixated with the connective expanded to the dorsal

surface, 0.7–0.8 mm long; *staminodes* with filaments inserted 3–3.2 mm from base of corolla tube, 1.1–1.3 mm long, sparsely hairy, with sterile lobes 0.2–0.3 mm long. *Ovary* 1.6–1.8 mm long, 1.1–1.3 mm wide, glabrous; style 4.1–4.3 mm long; stigma lobes 0.05–0.06 mm long. *Mericarps* not seen.

*Other specimen examined.* WESTERN AUSTRALIA: [same location as the type], 09 Dec. 2012, R. Davis & P. Jobson RD 12235 (PERTH).

*Distribution and habitat.* *Westringia ophioglossa* is only known from one roadside population east of Maya (Figure 1). It occurs in open mallee woodlands and is associated with *Eucalyptus leptopoda* subsp. *arctata* and *Grevillea paradoxa*.

*Conservation status.* With only a single roadside population of five plants, *W. ophioglossa* has been recently listed as Priority One under DEC Conservation Codes for Western Australian Flora, as *Westringia* sp. Maya (R. Davis & P. Jobson RD 12235) (Western Australian Herbarium 1998–). A search of surrounding road verges and bushland in the immediate vicinity failed to uncover further populations.

*Phenology.* *Westringia ophioglossa* flowers from late November to December.

*Etymology.* The species epithet is derived from the Greek *ophis* (a snake) and *glossa* (tongue) in reference to the lateral lobes of the corolla being deeply divided, resembling a snake's tongue.

*Notes.* *Westringia ophioglossa* has leaves in whorls of four and can be easily recognised by its tightly revolute leaf margins which obscure the midrib and its deeply divided abaxial median and lateral corolla lobes. The lateral corolla lobes have a purple spot situated in the middle of the lobe. The bracts are also distinctive in being rhombic in shape and tightly revolute in the distal portion.

#### ***Westringia fitzgeraldensis* R.W.Davis & P.Jobson, sp. nov.**

*Type:* [Fitzgerald River National Park], Western Australia [precise locality withheld for conservation reasons], 24 September 2011, D. Rathbone DAR 621 (*holo*: PERTH 08392285; *iso*: CANB).

*Westringia* sp. Fitzgerald (D. Rathbone DAR 621), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 17 December 2012].

Erect, open, perennial *shrubs* to 1.2 m high; branches erect, terete to sub-quadrangular, with moderate to dense, spreading hairs 0.2–0.7 mm long. *Leaves* in crowded whorls of 4, petiolate, the petioles 1–1.9 mm long; lamina linear, 7.5–11.1 mm long, 1.1–1.6 mm wide, with margins strongly revolute, the midrib clearly visible; adaxial surface with moderately dense, spreading to antrorse hairs 0.2–0.7 mm long, these sparser on abaxial surface. *Inflorescences* depressed-globose to ellipsoid, with moderately clustered bracts, bracteoles and calyces held close together but outer bracts looser, 8–12-flowered, 5–7 mm long, (8–)10–15 mm wide. *Bracts* rigid, rhombic, with distal half tightly involute, expanded in middle portion, then tapering towards base, 6.1–6.8 mm long, 1.6–1.8 mm wide, the margins ciliate; abaxial surface with moderately dense, antrorse hairs 0.2–0.4 mm long; adaxial surface with sparse, antrorse hairs 0.2–0.4 mm long on distal half, becoming glabrous on lower half; apex rounded. *Bracteoles* dissimilar to bracts, erect, much longer than the calyx tube, narrowly oblanceolate, 3.9–4.2 mm long, 0.5–0.8 mm wide, the margins densely ciliate; abaxial surface with moderately dense, antrorse hairs 0.2–0.3 mm long, mostly on medial portion; adaxial surface mostly glabrous,

with some sparse, antrorse hairs 0.2–0.3 mm long on distal portion; apex attenuate. *Calyx* 3.9–4.2 mm long, mostly glabrous with some sparse, antrorse to appressed hairs 0.2–0.3 mm long along medial section of the lobes and continuing down the tube; lobe margins ciliate; interior with very sparse, appressed, antrorse hairs, with short, sparse, glandular hairs mostly on lobe portion; *tube* obtriangular, 2–2.2 mm long, slightly rounded at base; *lobes* not or only slightly imbricate at base, ovate, usually slightly shorter than tube, 1.5–2.3 mm long, 0.9–1.1 mm wide at base, the apex apiculate. *Corolla* 6.5–7 mm long, white, lacking spots on lobes; exterior surface with sparse hairs on middle and upper portion of tube; interior surface with sparse, appressed hairs 0.1–0.2 mm long around throat; abaxial median lobe obovate to spatulate in outline, 2.1–2.3 mm long, 2.4–2.6 mm wide, the margins entire to slightly crenulate at apex, the apex flabellate to slightly emarginate; lateral lobes obovate to narrowly obovate, 1.6–1.8 mm long, 1.3–1.5 mm wide, the margins entire, the apex rounded; adaxial median lobes orbicular, 1.8–2.1 mm long, 1.6–1.7 mm wide, entire, the apex rounded. *Fertile stamens* with filaments inserted 1.6–1.7 mm from base of corolla tube, 3.1–3.3 mm long, with spreading hairs on proximal half, their anthers basifixated with the connective expanded to the dorsal surface, 0.9–1.1 mm long; *staminodes* with filaments inserted 1.7–1.9 mm from base of corolla tube, 1.1–1.2 mm long, glabrous, with sterile lobes 0.2–0.3 mm long. *Ovary* 0.6–0.8 mm long, 0.6–0.7 mm wide, glabrous; style 4.3–4.5 mm long; stigma lobes 0.14–0.15 mm long. *Mericarps* not seen.

*Distribution and habitat.* *Westringia fitzgeraldensis* occurs in a large valley west of Hopetoun in the Fitzgerald River National Park. It inhabits gentle slopes on alluvial, orange-brown loam with quartzite

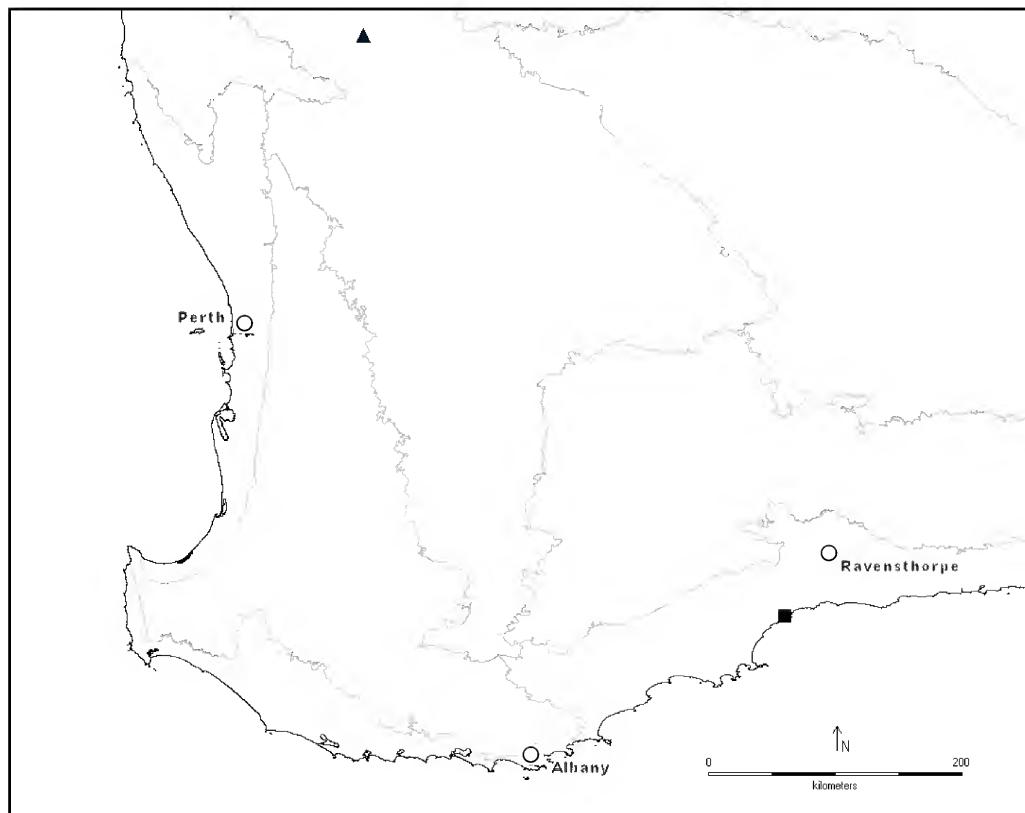


Figure 1. Distribution of *Westringia fitzgeraldensis* (■) and *W. ophioglossa* (▲) in Western Australia.

fragments in open mallee woodlands. Associated species include *Eucalyptus uncinata*, *E. redunca*, *E. conglobata* subsp. *perata*, *Melaleuca pomphostoma*, *M. suberosa* and *Siegfriedia darwinioides* (Figure 1).

*Conservation status.* The single known population of *W. fitzgeraldensis* is reserved in the Fitzgerald River National Park. It has been recently listed as Priority Two under DEC Conservation Codes for Western Australian Flora, as *Westringia* sp. Fitzgerald (D. Rathbone DAR 621) (Western Australian Herbarium 1998–).

*Phenology.* The single collection of *W. fitzgeraldensis* was in flower in mid- to late September.

*Etymology.* This species is currently only known from the Fitzgerald River National Park and is named after the place where it occurs.

*Notes.* *Westringia fitzgeraldensis* has leaves in whorls of four much like *W. capitonia*; however, it differs in having stems and leaves sparsely to densely hairy (glabrous in *W. capitonia*). The bracts are distinctively rhombic in *W. fitzgeraldensis* and tightly involute in the distal portion, while *W. capitonia* has bracts that are ovate or tending to elliptic to obovate in the distal part of the inflorescence.

#### **Modified key to species of *Westringia* sect. *Cephalowestringia* (after Guerin 2009: 127)**

1. Leaves per whorl 3
  2. Leaf margins fused to each other or held close together abaxially, midrib obscured, leaves linear-terete; bracts longitudinally ridged; adaxial corolla lip 0.5–0.6 mm long ..... ***W. acifolia***
  - 2: Leaf margins fused to abaxial leaf surface, midrib prominent, leaves oblong to linear; bracts not ridged (midrib prominent); adaxial corolla lip 0.9–1.7 mm long ..... ***W. cephalantha***
- 1: Leaves per whorl 4 or 5
  3. Leaves per whorl 4
    4. Leaf margins revolute, obscuring midrib..... ***W. ophioglossa***
    - 4: Leaf margins revolute but the midrib not obscured, prominent
      5. Leaves and stems glabrous, leaf margins revolute and fused to abaxial leaf surface..... ***W. capitonia***
      - 5: Leaves and stems pubescent, leaf margins revolute but not fused to abaxial leaf surface ..... ***W. fitzgeraldensis***
  - 3: Leaves per whorl 5 ..... ***W. discipulorum***

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We would like to thank Kevin Thiele for his on-going support, and Ryonen Butcher, Mike Hislop and Greg Guerin for their suggestions towards the improvement of this manuscript. We would also like to thank Damien Rathbone for bringing *W. fitzgeraldensis* to our attention, and Steve Dillon for his assistance with the distribution map.

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***Acacia gibsonii*, a distinctive, rare new species of *Acacia* sect. *Juliflorae* (Fabaceae: Mimosoideae) from south-west Western Australia****Bruce R. Maslin**

Western Australian Herbarium, Department of Parks and Wildlife,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983  
Email: Bruce.Maslin@dpaw.wa.gov.au

**Abstract**

Maslin, B.R. *Acacia gibsonii*, a distinctive, rare new species of *Acacia* sect. *Juliflorae* (Fabaceae: Mimosoideae) from south-west Western Australia. *Nuytsia* 23: 277–281. *Acacia gibsonii* Maslin, a new species with distinctively short, 3-nerved phyllodes and short spikes, and having affinities to *A. incongesta* R.S.Cowan & Maslin is described. The species is known from a geographically very restricted area of greenstone hills between Norseman and Hyden. It is currently listed by its phrase name, *Acacia* sp. Lake Johnson (N. Gibson & M. Lyons 1959), as Priority One under the Department of Environment and Conservation's Conservation Codes for Western Australian Flora.

**Introduction**

In recent years, the Department of Environment and Conservation (DEC; now the Department of Parks and Wildlife) has undertaken a survey program of the greenstone belts and the Banded Iron Formation (BIF) ranges of the Yilgarn Craton in southern Western Australia. These hitherto poorly known habitats were subsequently shown to be biologically very diverse with some containing a high number of endemic or near-endemic taxa, many of which were undescribed. The new species described here was discovered during the course of one of these surveys but was insufficiently known to be included in the dedicated issue of *Nuytsia* that provided formal scientific description of many of these taxa (see *Nuytsia* vol. 17, 2007).

**Taxonomy*****Acacia gibsonii* Maslin, sp. nov.**

*Type*: south of Hyden–Norseman Road, Western Australia [precise locality withheld for conservation purposes], 5 September 2012, N. Gibson 6434 (*holo*: PERTH 08396086; *iso*: MEL).

*Acacia* sp. Lake Johnson (N. Gibson & M. Lyons 1959), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 20 February 2013].

Low, spreading, somewhat straggly *shrubs* typically *c.* 0.5(–1) m tall and to 1.5 m diam. *Branchlets* terete, obscurely ribbed, reddish brown aging light grey and slightly roughened, sparsely to moderately muriculate by minute, red-brown, glandular trichomes at extremities, glabrous on mature branchlets. *Stipules* ±persistent, triangular, inconspicuous, 0.5–0.8 mm long, scarious. *Phyllodes* oblong to oblong-elliptic or oblong-obovate or sometimes slightly sigmoid, 6–13 mm long, 1.5–3 mm wide, sometimes crowded on very short branchlets which commonly grow out, straight or very shallowly recurved, ascending to erect with some ±patent, glabrous except for minute, red-brown, glandular trichomes on the normally sparsely tuberculate main nerves and margins of most phyllodes, green; prominently 3-nerved on each face, the nerves raised (at least when dry) and widely spaced, sometimes (on widest phyllodes) with a less pronounced, occasionally sparingly branched nerve between the main nerves; *apex* excentrically mucronate, the mucro 0.4–0.6 mm long, hard, ±pungent and dark brown; *base* equal or unequal; *pulvinus* 0.3–0.5 mm long, resinous or not resinous. *Gland* obscure, situated on upper margin of phyllode 0.5–1 mm above the pulvinus, circular, minute. *Inflorescences* simple, single within axil of phyllodes; *spikes* 5–7 mm long (dry), golden, flowers rather densely arranged within spikes; *receptacles* moderately hirsutulous; *peduncles* to 1 mm long, appressed puberulous; *basal peduncular bract* single, persistent, ovate, shallowly concave, brown, fimbriolate. *Bracteoles* spatulate, 0.6–0.7 mm long, claws narrowly oblong, laminae widely ovate, 0.4–0.5 mm wide, aging brown and ciliolate. *Flowers* 4-merous; *sepals* very shortly united at base, membranous, narrowly oblong or spatulate,  $\frac{2}{3}$  length of petals, sparsely hairy; *petals* 1–1.2 mm long, glabrous or sometimes sub-glabrous, nerveless. *Pod* (only one seen) ±tightly 1½ coiled, prominently rounded over seeds but not or scarcely constricted between them, *c.* 12 mm long (unexpanded length), 2.5 mm wide, thinly coriaceous, glabrous, mid- to dark-brown, finely longitudinally nerved, marginal nerve not or scarcely thickened. *Seeds* longitudinal in pods, obloid, 2–2.5 mm long, 1.5 mm wide, compressed (*c.* 1.3 mm thick), black, shiny; *areole* ‘u’-shaped, open towards the hilum, *c.* 0.5 × 0.3 mm; *pleurogram* obscure; *funicle* filiform, expanded into a conspicuous, pileiform, creamy white *aril* that is only slightly shorter than the seed. (Figure 1)

*Characteristic features.* *Branchlets* sparsely to moderately muriculate by minute, red-brown, glandular trichomes at extremities. *Phyllodes* small (6–13 × 1.5–3 mm), glabrous except normally with minute, red-brown, glandular trichomes on normally sparsely tuberculate main nerves and margins, with 3, prominent, widely-spaced main longitudinal nerves, excentrically mucronate with ±pungent point. *Spikes* short (5–7 mm long when dry), sessile or sub-sessile (peduncles to 1 mm long). *Flowers* 4-merous; *sepals* very shortly united at base, narrowly oblong or spatulate,  $\frac{2}{3}$  length of petals. *Pod* ±tightly 1½ coiled, 2.5 mm wide, glabrous, brown. *Seeds* small (2–2.5 × 1.5 mm); *aril* large, pileiform and creamy white.

*Other specimens examined.* WESTERN AUSTRALIA: [localities withheld for conservation purposes] 15 Sep. 2011, P.G. Armstrong PA 11/577 (NSW, PERTH); 3 Dec. 2011, P.G. Armstrong PA 11/720 (PERTH); 10 Apr. 2012, N. Gibson 6444 (AD, CANB, K, PERTH); 21 Sep. 1994, N. Gibson & M. Lyons 1959 (PERTH).

*Distribution.* Known from a single locality south of the road between Norseman and Hyden, south-west Western Australia. It occurs on two adjacent hills within the Lake Johnston Greenstone Belt (Gower & Bunting 1976) which is an extensive belt of greenstone that extends *c.* 50 km from Round Top Hill (120 km E of Norseman) south-east to the Bremer Range (100 km SW of Norseman). This greenstone belt is comprised of series of highly metamorphosed igneous and sedimentary sequences Romano (2012). Although the belt has been the subject of some floristic survey (Gibson & Lyons 1998) the area is somewhat difficult to access and therefore further surveys may possibly reveal further populations of the new species.

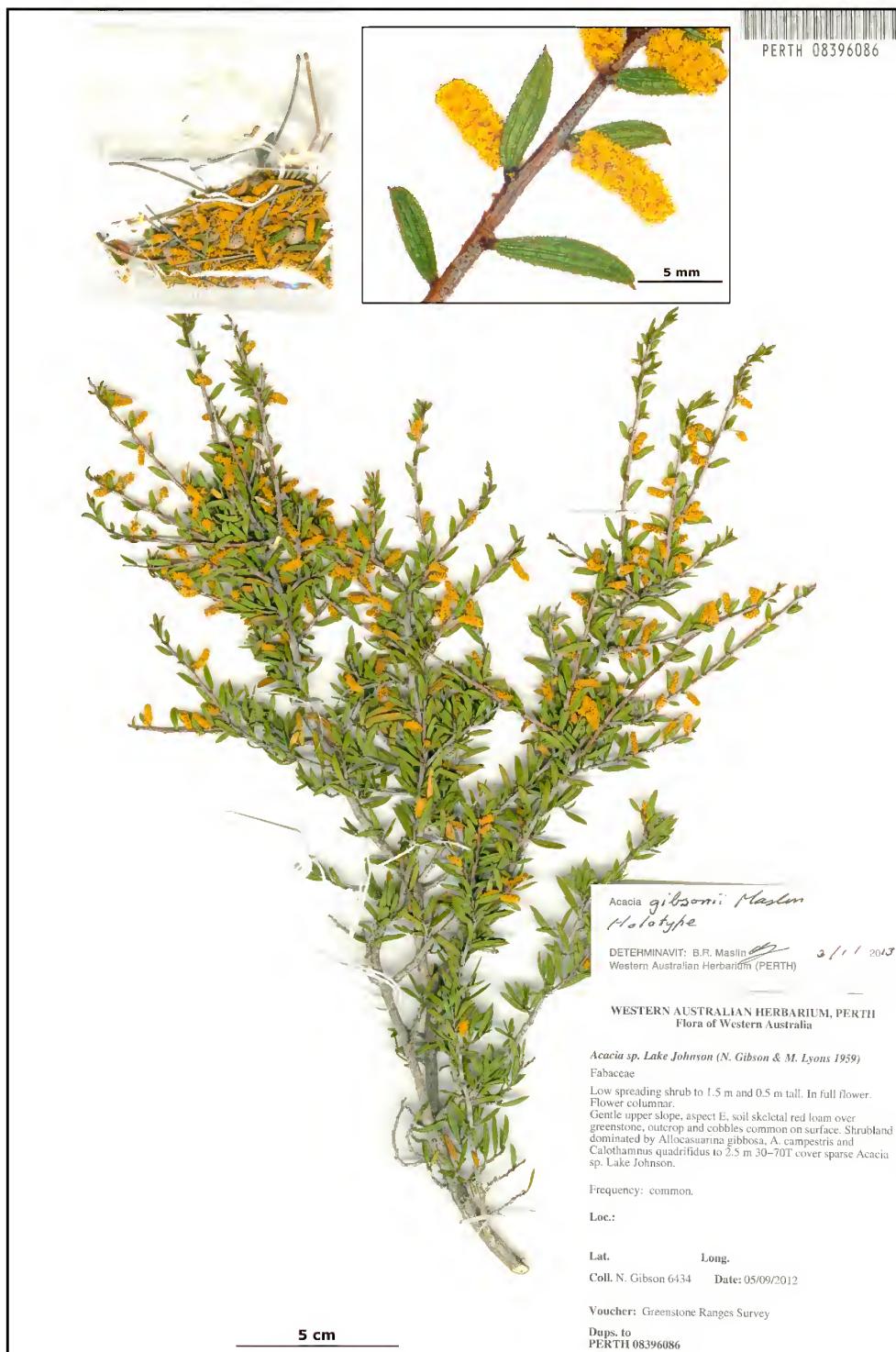


Figure 1. Holotype of *Acacia gibsonii* (PERTH 08396086) with photomicrograph insert of portion of branchlet showing small, strongly 3-nerved phyllodes and short spikes.

**Habitat.** Grows in skeletal red loam soils over greenstone on gentle rocky slopes in shrubland dominated by *Allocasuarina campestris*, *A. globosa* and *Calothamnus quadrifidus*. Although it extends to the clay flats surrounding these low hills, it is not especially common in these regions which are dominated by *Acacia acuminata*, *Allocasuarina campestris*, *Eucalyptus yilgarnensis* and *E. oleosa*.

**Phenology.** Because of the paucity of collections it is difficult to precisely determine the phenology of this species. However, extant collections show it flowering from mid-September to late October, and judging from these collections it is likely that flowering would extend to about mid-November. The single fruiting specimen (possessing just one pod) was collected in early December; this specimen was one of 1,000s of plants inspected at the time. The remainder were sterile.

**Conservation status.** *Acacia gibsonii* is listed as Priority One under DEC Conservation Codes for Western Australian Flora, as *Acacia* sp. Lake Johnson (N. Gibson & M. Lyons 1959) (Smith 2012). The species is locally common (many thousands of plants) where it occurs; however, it has a very restricted distribution that is outside the conservation estate.

**Etymology.** The botanical name honours Dr Neil Gibson, Principal Research Scientist with the Department of Parks and Wildlife. Neil co-discovered (with Michael Lyons) this species in September 1994, and it is very appropriate that this, and other of his achievements, be recognised here. Over the past 24 years Neil has been involved in extensive floristic surveys in south-west Western Australia, with a particular emphasis on the Swan Coastal Plain (Gibson *et al.* 1994), wheatbelt (Gibson *et al.* 2004) and the greenstone and banded ironstone ranges of the Yilgarn (Gibson *et al.* 2012). He was also involved in a floristic survey of the Pilbara region and has made a significant contribution to botanical history through his translation of the seminal work by L. Diels and E. Pritzel on the biogeography of Western Australia (Diels 2007).

**Common name.** Gibson's Wattle.

**Affinities.** *Acacia gibsonii* is a member of *Acacia* Mill. sect. *Juliflorae* (Benth.) Maiden & Betche and possesses the following combination of taxonomically important characters: phyllodes flat, 3-nerved and sub-pungent, flowers 4-merous and aggregated into ±sessile spikes, and sepals free or almost so. The only other *Acacia* possessing these attributes is *A. incongesta* R.S.Cowan & Maslin (Cowan & Maslin 1995: 48), a geographically restricted species that occurs near Peak Charles, c. 80 km south-east of where *A. gibsonii* is found. Although these morphological characters strongly indicate affinities between the two species they superficially look very dissimilar, with *A. incongesta* being readily distinguished in the following ways: phyllodes much larger (4–7 cm × 3–4.5 mm), spikes longer (15–25 mm), cream-coloured and loosely flowered, sepals shorter ( $\frac{1}{4}$ – $\frac{1}{3}$  length of petals), pods much larger (to 10.5 cm long, 4 mm wide) and curved (not coiled), and seeds larger (3–4 × 2–2.5 mm) with a larger areole. Furthermore, *A. incongesta* is typically a taller shrub (0.6–4 m) which grows on soils derived from granite. Although both species possess the relatively uncommon character of red-brown resin trichomes on their branchlets and phyllodes, these structures are less well-developed in *A. incongesta* than in *A. gibsonii*.

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## A revision of the species of *Hypocalymma* (Myrtaceae: Chamelaucieae) with smooth or colliculate seeds

Barbara L. Rye<sup>1,3</sup>, Peter G. Wilson<sup>2</sup> and Greg J. Keighery<sup>1</sup>

<sup>1</sup>Western Australian Herbarium, Department of Parks and Wildlife,  
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

<sup>2</sup>National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust,  
Mrs Macquaries Road, Sydney, New South Wales 2000

<sup>3</sup>Corresponding author, email: Barbara.Rye@dpaw.wa.gov.au

### Abstract

Rye, B.L., Wilson, P.G. & Keighery, G.J. A revision of the species of *Hypocalymma* (Myrtaceae: Chamelaucieae) with smooth or colliculate seeds. *Nuytsia* 23: 283–312 (2013). Most members of the south-western Australian genus *Hypocalymma* (Endl.) Endl. have seeds with a shallowly to very deeply pitted testa. Two small groups of species, both revised here, differ in having a smooth or colliculate testa. Both groups occur in humid environments in the extreme south-west of Western Australia and show vegetative adaptations consistent with this habitat preference. The larger group, *Hypocalymma* sect. *Cardiomyrthus* Schauer, is reinstated. A new combination, *H. minus* (Strid & Keighery) Keighery, is made, bringing the total species recognised to five, and lectotypes are selected for two synonyms, *H. boroniaceum* F.Muell. ex Benth. and *H. hypericifolium* Benth. The other group is extremely rare, consisting of the possibly extinct species *H. connatum* Strid & Keighery, and a new species known from a single population, *H. verticillare* Rye. The latter group, named here as *Hypocalymma* sect. *Verticilla* Rye, is readily distinguished by its 3-ridged young stems and consistently whorled leaves, and the new species is unusual in having extreme differences in the sizes of the anthers on different stamens within each flower. Molecular data indicate that sect. *Verticilla* is sister to sect. *Cardiomyrthus*. Evidence of taxonomic relationships is also presented from studies of hybridisation and insect associations.

### Introduction

*Hypocalymma* (Endl.) Endl. is a moderate-sized, myrtaceous genus belonging to the tribe Chamelaucieae DC. Although relatively restricted in its distribution, occurring only in the South-west Botanical Province of Western Australia (see Rye 2013: Figure 5C), the genus is morphologically diverse. Schauer (1844) and Bentham (1867) recognised three sections, but Strid and Keighery (2002) decided not to use sections for the more varied and numerous species of *Hypocalymma* known by that stage.

Recent molecular studies using four chloroplast regions (Lam *et al.* 2002; Wilson *et al.* 2004), have suggested that the smallest of Schauer's three sections, *Hypocalymma* sect. *Cardiomyrthus* Schauer, should be recognised as a distinct group. Several morphological differences that were uncovered during the current study, especially a difference in the seed testa, also suggest that sect. *Cardiomyrthus* should be recognised. While most species of *Hypocalymma* have a shallowly to deeply pitted testa (see Sweedman & Merritt 2006: 126; Rye & Trudgen 2008: Figure 3C), members of sect. *Cardiomyrthus* have a smooth or colliculate testa.

A second group of smooth-seeded *Hypocalymma* species, treated here as the new section *Verticilla* Rye, has such a distinctive morphology that its generic placement has been unclear. The first herbarium specimen belonging to this plant group was taken from a species displayed in a wildflower show in Perth in September 1935. This specimen was identified by Charles Gardner on the label as '*Baeckea Hypocalymma* or *Astartea* a new plant' after he had failed to find any match for it at Kew. No further material came to light and the taxon remained in obscurity for more than sixty years until it was included in a cladistic study (Foster 1996) and later described as *H. connatum* Strid & Keighery (Strid & Keighery 2002). Many of the leaves and almost all of the flowers and fruits had fallen from the stems of the single specimen of *H. connatum*; this may have contributed to two incorrect character states, *viz.* quadrangular stems and paired flowers, being given in the protologue. In fact, *H. connatum* is unusual in having three-angled stems, with leaves borne in alternating whorls of three and the number of flowers produced at each node varying from one to three.

A full revision of *Hypocalymma* sections *Cardiomyrthus* and *Verticilla* is presented here. In the remainder of the genus, i.e. the taxa with pitted seeds, most species seem to form a cohesive group that includes the type species (i.e. sect. *Hypocalymma s. str.*); however, a few atypical species need further study to determine whether they should be maintained within sect. *Hypocalymma s. lat.* or placed in a new section.

## Methods

Measurements were taken from well pressed, herbarium specimens, using the largest leaves on each specimen and taking care to measure the inflorescence and floral organs when they were fully mature. Few specimens are cited here because extensive lists of specimens have already been published in Strid and Keighery (2002). Some new or recently incorporated specimens are cited and also a few specimens with recently altered identifications.

Multiple images of seeds and other organs were taken with a Nikon Digital Head (DS-5M) controlled by a DS Camera Control Unit (DS-L1) and a montage of the images was collated using the Synopsics Auto-Montage Pro Version 5.03.0061 software.

## Sectional classification of *Hypocalymma*

### Taxonomic history

*Hypocalymma* (Endlicher 1837, 1840) originally consisted of the two species now known as *H. angustifolium* (Endl.) Schauer and *H. robustum* (Endl.) Lindl., the latter of which was recently selected (Rye 2010) as the lectotype for the genus. Schauer (1844) established three sections in the genus. Section *Eucalyymma* Schauer *nom. illeg.* [= sect. *Hypocalymma*], contained the lectotype *H. robustum* as well as *H. asperum* Schauer and *H. strictum* Schauer. Another section, *Astrocalymma* Schauer, consisted of *H. angustifolium* and *H. scariosum* Schauer. Schauer (1844) based his third section, *Cardiomyrthus*, on the single species *H. cordifolium* Lehm. ex Schauer and distinguished it from the other two sections partly by its distinctly pedunculate flowers. At that time, when there were so few species of *Hypocalymma* known, each section could be readily defined on the basis of the number of loculi and ovules per loculus in the ovary as follows:

1. Sect. *Eucalyymma* [= sect. *Hypocalymma*] with 2 loculi and 3 ovules per loculus.
2. Sect. *Astrocalymma* with 3 loculi and 1 ovule per loculus.
3. Sect. *Cardiomyrthus* with 3 loculi and 2 ovules per loculus.

Turczaninow (1862) named two additional sections for species that had 3-locular ovaries but these groups were not validly published as they did not include any diagnostic description. Section *Calocalymna* Turcz. *nom. inval.* was based on *H. speciosum* Turcz., a species with deep pink-purple flowers, a superior ovary and colliculate seeds. The other section, *Chrysocalymna* Turcz. *nom. inval.*, had pitted seeds; it contained the yellow-flowered species currently known as *H. linifolium* Turcz. and *H. xanthopetalum* F.Muell.

By the time Bentham (1867) published his treatment of *Hypocalymma* in *Flora Australiensis*, 13 of the species now recognised had been named. The increased range of morphological variation in the additional species included higher ovule numbers, 6–12 per loculus, in two species that Bentham added to section *Cardiomyrthus*. In modifying the infrageneric classification to accommodate the new species, Bentham used extra characters, including the degree of development of ridges on the ovary summit and whether or not the style was inserted in a cavity.

Niedenzu (1893) expanded the circumscription of *Hypocalymma* to include *Rinzia* Schauer, placing its species in sect. *Cardiomyrthus*, but subsequent authors mostly followed Bentham's placement of *Rinzia* as a section of *Baeckea* L. In a paper reinstating *Rinzia*, Trudgen (1986: 416, 418) considered *Hypocalymma* to be a close relative that differed in its 'more numerous and exserted stamens', and basifixated anthers apparently 'developed through the fusion of the filament to the lower part of the anthers'.

Foster (1996) raised the possibility that a new genus might be needed for the species now named *H. connatum*. His cladistic analysis supported the genus *Hypocalymma* s. lat. and placed *H. connatum* close to *H. cordifolium*, but he noted that characters not used in the analysis suggested that *H. connatum* was very distinctive.

Although Strid and Keighery (2002) did not recognise any sections in their revision of *Hypocalymma*, their systematic ordering of the species corresponded with the species groups recognised here. They placed 17 species with pitted seeds first, followed by the four species of sect. *Cardiomyrthus sensu* Bentham (1867) and then *H. connatum*. The last two of the 17 species with pitted seeds—*H. puniceum* C.A.Gardner and *H. melaleuroides* C.A.Gardner ex Strid & Keighery—were atypical of the genus in having the stamens much shorter than the petals. Three undescribed taxa—*H. puniceum* subsp. Cadoux (H. Demarz 10533), *H. sp.* Cascade (R. Bruhn 20896) and *H. sp.* Lake King (R.W. Purdie 3936)—also have a low stamen length to petal length ratio. These five taxa are referred to here as the *H. puniceum* group.

### Molecular sequencing

Recent molecular studies of several chloroplast regions (Lam *et al.* 2002; Wilson *et al.* 2004) indicate that *Hypocalymma* is much more closely related to *Astartea* DC. and *Cyathostemon* Turcz. than to *Rinzia*. Six species of *Hypocalymma* were sampled, three with pitted seeds and three with smooth or colliculate seeds. The three species with pitted seeds (one representative of each of the sections

*Astrocalymma*, *Chrysocalymna* nom. inval. and *Hypocalymma*) were placed together. However, the other three species sampled (two representatives from sect. *Cardiomyrthus* and one from sect. *Calocalymma* nom. inval.) formed a separate clade from that containing the taxa with pitted seeds.

Analysis of an expanded molecular dataset, with sequences from the nuclear ETS region added to the existing chloroplast data, was included in a presentation at the 2011 International Botanical Congress (abstract published as Wilson & Heslewood 2011). The nine species used in this analysis (Figure 1) are more diverse, including one representative of the *H. puniceum* group and one of the new section, *Verticilla*. Phylogenetic analysis of these nine species indicates that *Hypocalymma* is a monophyletic group, but with weak jackknife (jk) support (64% jk). The group divides into two moderately, to well, supported clades. In the first, with 84% jk support, the new section, *Verticilla*, is sister to a strongly supported (97% jk) clade comprising three species of sections *Cardiomyrthus* and ‘*Calocalymma*’. The second branch has *H. puniceum* very strongly supported (100% jk) as sister to another robust clade representing sections *Astrocalymma*, ‘*Chrysocalymna*’ and *Hypocalymma*. The topology of this part of the phylogeny suggests that further investigation might result in the *H. puniceum* group being treated as a distinct section.

### Hybridisation

Strid and Keighery (2002) noted the existence of natural hybrids between the widespread *H. angustifolium* s. lat. (sect. *Astrocalymma*) and a variety of other species with pitted seeds, including *H. robustum* (sect. *Hypocalymma*). The most extensive case of hybridisation (M. Trudgen pers. comm., K. Thiele pers. comm.) occurs at localities where *H. tetrapterum* Turcz. co-exists with the flat-leaved variant of the *H. angustifolium* complex, with the production of hybrid swarms. The informal name *Hypocalymma* sp. Cataby (G.J. Keighery 5151) applies to these hybrids.

The Botanic Gardens and Parks Authority has attempted to cross several large-flowered species (belonging to sect. *Cardiomyrthus* and the *H. puniceum* group) with *H. angustifolium* (sect. *Astrocalymma*) but no seed set resulted (D. Growns pers. comm.).

No natural hybrids have been recorded for species with smooth to colliculate seeds, either in the rare instances when they co-occur or the perhaps more numerous occasions where they occur with pitted-seeded species.

### Conclusion

All known cases of natural hybridisation occur either within or between the three named sections with pitted seeds, *Astrocalymma*, ‘*Chrysocalymna*’ and *Hypocalymma*, and there do not appear to be any clear morphological differences to define these three groups. It is concluded from this evidence, and also from the molecular data, that *Astrocalymma* and ‘*Chrysocalymna*’ should be treated as synonyms of sect. *Hypocalymma*. However, both the hybridisation data and the molecular data suggest that the *H. puniceum* group is distinctive.

Among the taxa with smooth to colliculate seeds, the molecular data indicate that sect. ‘*Calocalymma*’ should be considered a synonym of sect. *Cardiomyrthus* but that the *Verticilla* group is likely to be distinct. Morphological differences that support the recognition of these two groups as separate sections are outlined below.

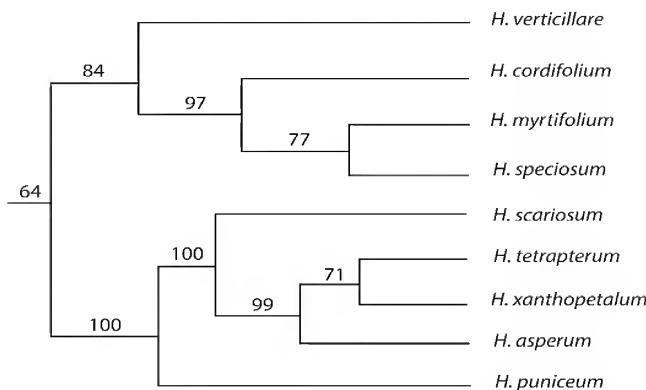


Figure 1. Preliminary phylogeny of *Hypocalymma* (from Wilson & Heslewood (2011), unpublished analysis of tribe Chamaeleuciae) showing jackknife supports.

## Morphology

The morphology of the new section *Verticilla* is compared with that of the previously named sections *Cardiomyrthus* and *Hypocalymma* in Table 1. Note that the *H. puniceum* group is excluded from the character states given in Table 1 for sect. *Hypocalymma* as it appears to be very distinctive, differing in having only one flower per axil, pedicels up to 2 mm long and seeds reaching a slightly higher maximum length of 2.5 mm. The main distinguishing character of the *H. puniceum* group, i.e. large petals that greatly exceed the stamens, is not listed in the table.

As can be seen from Table 1, sections *Cardiomyrthus* and *Verticilla* differ from the typical section mainly in their leaf, inflorescence and seed characters. They also differ from one another in their stems, leaves, inflorescence and androecium. Sect. *Verticilla* resembles the genus *Cyathostemon* in its androecium and in having solitary, distinctly stalked, axillary flowers. However, the flowers in sect. *Verticilla* have a long peduncle exceeding the pedicel whereas in *Cyathostemon* the peduncle is usually much reduced and greatly exceeded by the pedicel.

**Habit.** Sections *Cardiomyrthus* and *Verticilla* consist of small or moderate-sized shrubs, mostly less than 1 m high, although *H. phillipsii* Harv. may occasionally reach a height of about 1.5 m and the height of *H. connatum* is unknown. Two species, *H. cordifolium* and *H. verticillare*, are single-stemmed at the base, whereas the three species of sect. *Cardiomyrthus* that are endemic to the Stirling Range can produce multiple stems from a woody base. A third growth form, with adventitious roots produced from prostrate stems, is found only in *H. minus* (Strid & Keighery) Keighery.

**Stem shape and surface.** In cross-section the stems may be circular, 4-angled or 4-winged in sect. *Cardiomyrthus*, whereas they are 3-angled in sect. *Verticilla*. The surface is glabrous in sect. *Verticilla* and four species of sect. *Cardiomyrthus* but has short, terete, simple hairs in *H. phillipsii*. *Hypocalymma cordifolium* has the most prominently winged stems (Figure 2A) in the genus. These wings project from the stem in the same direction as the leaves below and at right angles to the leaves above. Consequently, the wings of each internode are at right angles to the wings of adjacent internodes.

**Table 1.** Comparison of the sections of *Hypocalymma*. Distribution districts are *Interim Biogeographic Regionalisation for Australia (IBRA) Version 6.1* regions (Department of the Environment, Water, Heritage and the Arts 2008). Rainfall is based on Bureau of Meteorology (2013) data for the last century. ‘Peduncle’ length includes the length of the secondary axis when present. Degree of unity of the filaments is defined as follows: *basal tube* = united for less than 1/4 of their length; *short tube* = united for c. 1/3 of their length; *long tube* = united for at least half of their length. The position of the inner protrusion on the seed is defined as follows: *around hilum* = base of the protrusion extends right around the base of the hilum; *above hilum* = base of the inner protrusion is above the hilum, except for narrow lateral wings.

Character	sect. <i>Cardiomyrthus</i>	sect. <i>Hypocalymma</i> excluding <i>H. puniceum</i> group	sect. <i>Verticilla</i>
<b>distribution</b>			
known districts	ESP, JF, SWA, WAR	AW, ESP, JF, MAL, SWA, WAR	WAR
annual rainfall	600→1,200 mm	300→1,200 mm	>1,200 mm
<b>young stems</b>			
angles	absent or 4	absent or 4	3
ridges	absent or 2	absent, 2 or 4	3
<b>leaves</b>			
arrangement	opposite	opposite	whorled
margins	recurved	usually level or incurved	recurved to revolute
colour	darker above	concolorous or darker below	darker above
venation	brochidodromous	only midvein visible	only midvein visible
oil glands	many and scattered	in several rows	in several rows
<b>inflorescence</b>			
flowers per axil	1–4	mostly 2	1
‘peduncle’ length	1.5–16 mm	0–2.5 mm	2–4 mm
pedicel length	0–0.8 mm	0–0.8 mm	0.7–1.2 mm
<b>androecium</b>			
filaments	10–50	12–150	15–26
position of long filaments	outermost or nearest to petals	outermost or nearest to petals	alternating with the short filaments
degree of unity	basal tube	basal or short tube	long tube
staminodes	rare or absent	rare or absent	antipetalous or absent
anther cells	± straight	often curved	straight
connective gland	dorsal	ventral or obscure	dorsal
<b>gynoecium</b>			
ovules per loculus	2 or 6–12	1–11	1 or 8–10
ovary summit	sometimes ± ridged	often ridged, rarely winged	not ridged
<b>seeds</b>			
length	0.8–1.7 mm	1.3–2.4 mm	1–1.3 mm
testa	smooth or colliculate	pitted	smooth
protrusion	above hilum	around hilum	above hilum

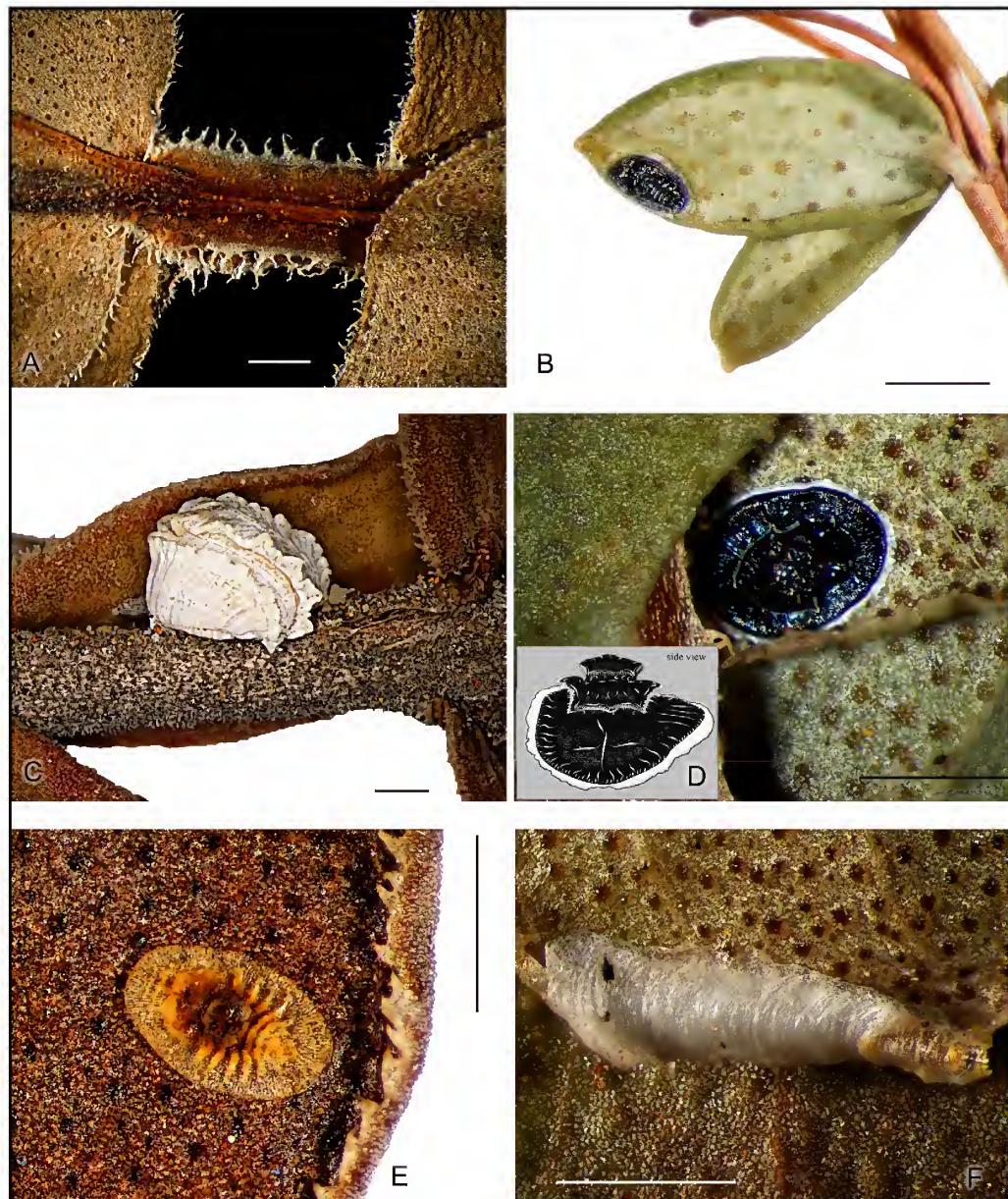


Figure 2. Images of vegetative characters and scale-forming insects. A – winged stem between two pairs of leaves in *Hypocalymma cordifolium*; B – black scale of a white fly larva attached to the pale undersurface (close to the distinctly darker, revolute margin) on a leaf of *H. verticillare*; C – shell-like scale of a female *Callococcus* larva on a hairy stem of *H. xanthopetalum* (sect. *Hypocalymma*); D – image and drawing of a white fly scale, with the empty scales of two previous instars retained on its dorsal surface, attached to a leaf of *H. cordifolium*; E – translucent brown scale, possibly a coccid, close to a recurved margin on a leaf of *H. cordifolium*; F – diaspid scale on a leaf of *H. cordifolium*. Scale bars are 1 mm. Images taken by Alex Williams from R.F. Williams s.n. 16 Sep. 1932 (A, E), B.L. Rye 250505 & E.D. Middleton (B), M. Rose 111 (C) and R. Davis 7980 (D, F).

**Stem ridges.** The 3-angled stems in sect. *Verticilla* are also 3-ridged, both characters being related to the ternate leaf arrangement in this plant group (Figure 3A). From the base of each petiole, a prominent, rounded, smooth ridge extends down to the next node; the ridge is broadest distally, tapering towards its base. Like the leaves, the three ridges of each internode alternate their orientation with those of the previous internode. Less prominent ridges occur on the stems of some species of sect. *Hypocalymma* but these may continue down the stem until they reach the top of the next leaf that is orientated in the same direction as the leaf where they began. These species, all with an opposite-decussate arrangement of the leaves, may therefore have a total of four ridges along each internode, even though only two ridges arise at each node. In sect. *Cardiomyrthus* there are usually no ridges or only 2 slight ridges.

**Leaf phyllotaxy.** All species of sect. *Cardiomyrthus* have opposite and decussate leaves, although one specimen (B.L. Rye 290125) from the easternmost population of *H. minus* has a few stems or portions of stems with leaves in whorls of three in addition to stems with uniformly opposite leaves. Section *Verticilla* is readily distinguished by its regular arrangement of the leaves in alternating whorls of three, a character found in very few species of the tribe Chamaeleuciae. Indeed, uniformly whorled leaves are very rare or absent in all tribes of Myrtaceae in south-western Australia.

**Leaf size.** Compared with other members of the tribe Chamaeleuciae, the taxa described here have medium-sized to very large leaves. *Hypocalymma myrtifolium* Turcz. and *H. phillipsii* have leaves up to 40 mm long and 20 mm wide; in terms of their surface area, these leaves are the largest in the tribe.

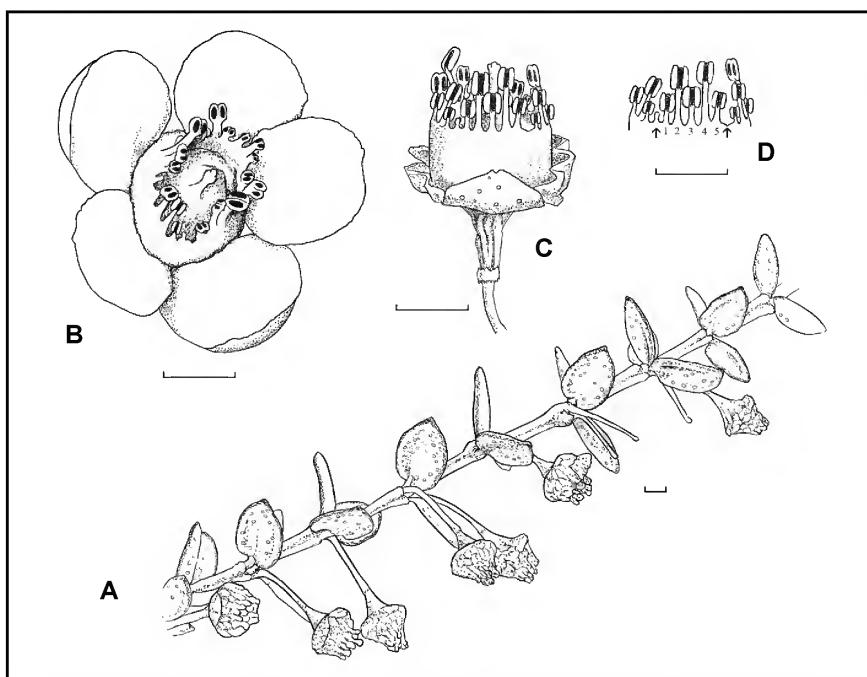


Figure 3. *Hypocalymma verticillare* A – fruiting branchlet, showing ridged stem, whorled leaves and long, curved peduncles; B – flower, showing an immature style and irregular circle of very heterogeneous anthers with bi-coloured thecae; C – fruit, showing a mature style surrounded by filaments united into a long, regular tube; D – part of the androecium from the previously illustrated fruit, with the five anthers opposite the closest sepal numbered and with arrows showing a staminode and a gap (opposite abscised petals). Scale bars are 1 mm. Drawn by Lisa Rye using photographs taken by Peter Rye (A, B) and from E.D. Middleton 702 (C, D).

*Petioles.* Both species of sect. *Verticilla* have short but very well defined petioles. Petioles are short or more commonly absent in sect. *Cardiomyrtus*, with *H. minus* being the only species that is regularly petiolate.

*Leaf blades.* All species of sect. *Cardiomyrtus* have broad, thin leaves dotted with very numerous, minute oil glands (see Figure 2E). On each side of a prominent midvein, a faint pattern of venation is often visible, with multiple, parallel secondary veins extending towards the margin and then linking up to form an intramarginal vein. This kind of pinnate venation, known as brochidodromous, was considered by Johnson and Briggs (1984) to be the primitive kind of venation in the Myrtaceae as a whole. Similar venation occurs in the eastern Australian species *Sannantha pluriflora* (F.Muell.) Peter G.Wilson, but most members of the Chamaeleacieae have very reduced leaves that either lack any obvious venation or have only the midvein clearly visible. The upper surface of the leaf in sect. *Cardiomyrtus* is darker than the undersurface and the margins are recurved.

In leaves of sect. *Verticilla* only the midvein is visible and there are fewer oil glands, which occur mainly in two or three irregular rows on each side of the midvein. As in sect. *Cardiomyrtus*, the upper surface is darker but the margins are more strongly recurved or revolute (Figure 2B).

*Inflorescence type.* Briggs and Johnson (1979) suggested that the basic inflorescence in *Hypocalymma* is the monad, but noted that the flowers are frequently borne on a brachyblast, a short axillary shoot with only one or two nodes that usually does not grow on. The paired flowers, therefore, constitute what these authors referred to as a conflorescence. This can be observed easily in sect. *Cardiomyrtus* where the flowers are usually in pairs in the axils, borne on a much reduced lateral axis, each one subtended by a single bract. When four flowers occur, the lateral short shoots are conspicuous and can be up to 12 mm long. All flowers have stalks (referred to in the descriptions below as secondary axes) below the bracteoles, although these can be very short in *H. phillipsii* and *H. myrtifolium*. Bracteoles occur at the base of the hypanthium, which is often obtuse but narrows to a distinct anthopodium (also known as a pedicel) in some species, e.g. *H. myrtifolium*. The bracteoles tend to persist longer in this section than in sect. *Verticilla*.

Section *Verticilla* has solitary axillary flowers, which could be interpreted as the plesiomorphic state. There are, therefore, a maximum of three flowers per node arranged in alternating whorls of three, although some nodes have one or two barren axils and are therefore only 1- or 2-flowered. Once pressed, flowering branchlets often appear to have all the flowers to one side rather than evenly arranged on the stem because the peduncles are fairly long and curve downwards so that the flowers are somewhat pendulous. The pedicels are distinctly shorter than the peduncles. The bracteoles are narrow and scarious, and are apparently either caducous or deciduous.

*Calyx and corolla.* Sepals are well developed in all species of *Hypocalymma*, although much shorter than the petals. In sections *Cardiomyrtus* and *Verticilla* the sepals are obtuse, with a petaline margin and with the midrib herbaceous but not prominently ridged. The latter section has shortly but narrowly clawed, white petals, which are widely spreading in flower and deciduous in fruit. In sect. *Cardiomyrtus*, four species are white-flowered but one has deep pink petals, and the petals of three of the species are persistent in fruit.

*Stamen number and degree of fusion.* In all species of *Hypocalymma* the stamens are of a varied rather than a fixed number in each flower. Most members of sections *Hypocalymma* and *Cardiomyrtus* have stamens arranged in two or three series and shortly united at the base into a complete circle. However,

*H. minus* of sect. *Cardiomyrthus* has the lowest numbers of stamens in the genus, down to ten per flower, with all or most filaments free, and has no stamens opposite the petals. In sect. *Verticilla* the filaments are broader than those of sections *Hypocalymma* and *Cardiomyrthus* and they are united for about half their length. The height of the united part of the androecial ring is more or less uniform around the circle (see Figure 3C).

*Reduced stamens and staminodes.* Unlike all other species of *Hypocalymma*, *H. verticillare* (sect. *Verticilla*) commonly has staminodes. Its stamens appear to form five antisepalous groups because the free parts of the filaments differ greatly in size (Figure 3B–D). There is usually a solitary staminode or a very small stamen (with a very small anther) directly opposite each petal, although this may sometimes be replaced by a small gap (see Figure 3D), and there are two to five stamens opposite each sepal. The longest stamens have a large anther and always occur adjacent to shorter stamens with a smaller anther. Although the other species of sect. *Verticilla*, *H. connata*, lacks staminodes and has little variation in anther size, it is similar to *H. verticillare* in having long and short filaments alternating.

*Anthers.* Anthers in sections *Cardiomyrthus* and *Verticilla* are basifixed or almost basifixed. They have a free connective gland and well defined, longitudinally dehiscent thecae, which are usually straight and parallel. The connective tends to be broader and the thecae shorter and more strictly introrse in sect. *Verticilla* than in sect. *Cardiomyrthus*. The connective gland is most obvious in young anthers. Once the anthers have dehisced, the connective gland may be difficult to see in sect. *Cardiomyrthus* although it is always obvious in *H. minus* and in sect. *Verticilla*. The latter section has the thecae strongly bi-coloured (Figure 3B) with the pale outside rim very clearly distinguished from the central reddish area of dehiscence.

*Pollen.* Longicolpate pollen has been recorded in two sections of *Hypocalymma*. Two species of sect. *Hypocalymma*, *H. robustum* (Pike 1956: Figure 82) and *H. angustifolium* (Patel *et al.* 1984: Figure 44E, G), have a patterned surface, straight sides (rather than convex or concave) and very long colpi reaching to near the centre of the grain but not meeting. Pollen of similar size and other characteristics was recorded but not illustrated (Pike 1956) for *H. phillipsii* of sect. *Cardiomyrthus*. Thornhill *et al.* (2012) adopted a somewhat different terminology for colpal morphology, using the term ‘brevicolpate’ in place of ‘longicolpate’. Their results generally confirmed the published observations cited above except that they also recorded pollen with convex and concave sides, and there was variation in the colpal morphology of *H. xanthopetalum* of sect. ‘*Chrysocalymma*’, including both acolpate and syncolpate forms. The question of whether or not such variation in pollen morphology has phylogenetic value must await a more comprehensive study of pollen variation in the genus.

*Gynoecium.* In sect. *Hypocalymma* the ovary is 2- or 3-locular and its summit is often prominently ridged along the centre of each loculus where the line of dehiscence is located. Many species completely lack a depression for the style, instead having the style base thick and continuous with the raised intersection of the ridges at the centre of the ovary summit, while other species have the style base inserted in a shallow or deep depression. Sections *Cardiomyrthus* and *Verticilla* have a 3-locular ovary with the summit 3-lobed but not or scarcely ridged, and the style is always in a depression that reaches down to the level of the placentas.

*Fruits.* The capsule of sect. *Verticilla* is half-inferior to two-thirds-superior, with the superior part closely surrounded by the persistent, connate part of the androecium. In sect. *Cardiomyrthus* the capsule is half-inferior to almost fully superior and the stamens tend to be shed before the fruit matures unless they are retained within persistent closed petals.

**Seeds.** The seeds of sect. *Hypocalymma* (Figure 4A) are 1.3–2.4 mm long and have an irregularly ovoid, shallowly to very deeply pitted, brown body containing the seed and a prominent swelling extending from the top of the inner surface down most of the length of the seed but not reaching the base. This inner protrusion is concentrated above the hilum but often also narrowly encircles the base of the hilum. In sections *Cardiomyrthus* (Figure 4B) and *Verticilla* (Figure 4C, D) the seeds are of a similar shape to those of sect. *Hypocalymma* but they are smaller (0.8–1.7 mm long) on average and the inner protrusion does not extend around the base to the hilum. The testa is colliculate in *H. speciosum* and smooth in the other six species.

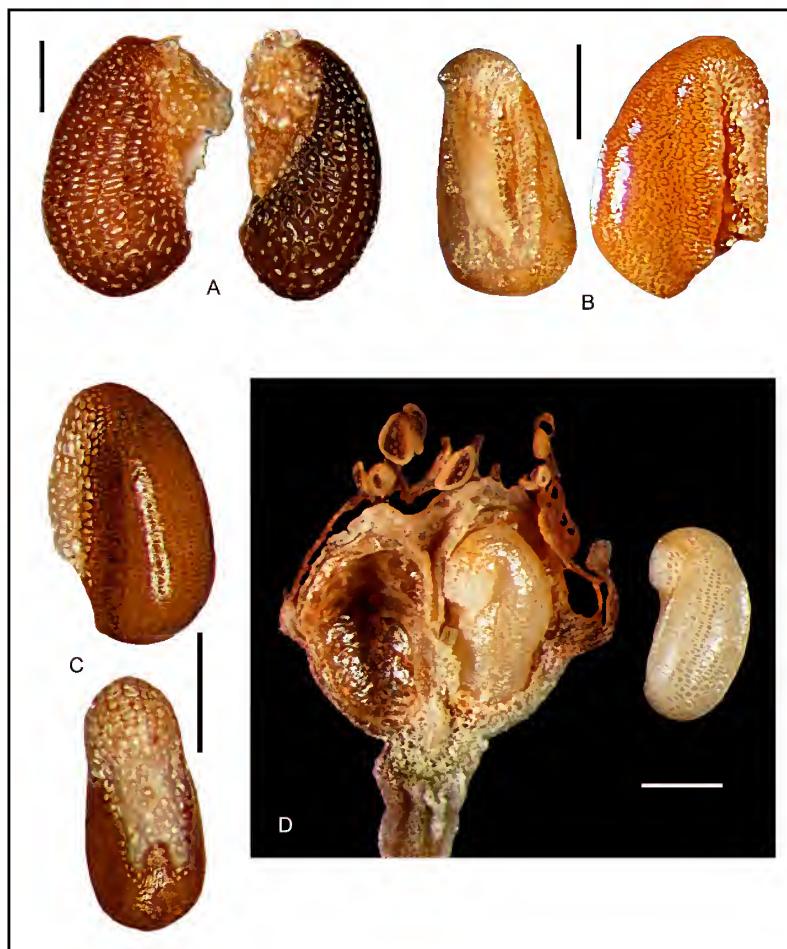


Figure 4. Images of seeds. A – lateral view of pitted seeds of the sect. *Hypocalymma* species *H. elongatum* (Strid & Keighery) Rye; B – inside and lateral views of smooth seeds of *H. myrtifolium*; C – inside and lateral views of smooth seeds of *H. connatum*; D – lateral view of smooth seeds of *H. verticillare*, with one *in situ* in a fruit. Scale bars are 0.5 mm. Images taken by Alex Williams from J.M. Powell 3276 & M. Hardie (A), A.S. George 3124 (B), C.A. Gardner s.n. Sep. 1935 (C) and B.L. Rye 250504 & E.D. Middleton (D).

*Chaff*. In the species with 8–12 ovules per loculus, some ovules in each loculus usually fail to develop into a fertile seed. These chaff pieces are reduced in size but mostly still have a crustaceous testa. In *H. cordifolium* and *H. minus*, which have two ovules per loculus, a highly compressed, membranous chaff piece is produced in loculi that have a single seed. As there is only one ovule per loculus in *H. verticillare*, there is no possibility of chaff being produced in the same loculi as seeds.

### Habitat

Most members of the tribe Chamelaucieae occur in regions with less than 600 mm annual rainfall. *Hypocalymma* sections *Cardiomyrthus* and *Verticilla* are restricted to parts of the far south-west of Western Australia (Figure 5) where the annual rainfall varies from about 600 to over 1,200 mm (see Table 1). The relatively high humidity of their environment is reflected in some aspects of their morphology. For example, the very broad, stem-clasping leaves of *H. cordifolium* (sect. *Cardiomyrthus*) often form a more or less complete circle of green at each node, similar in effect to the whorled leaves in sect. *Verticilla* in terms of providing a large surface area for photosynthesis.

Section *Hypocalymma* is much more speciose and widespread than the two other sections and has its greatest development in the northern sandplains, although it is still entirely restricted to the South West Botanical Province of Western Australia. Within the genus as a whole, there is a tendency for larger seeds with a thicker testa to occur in species from the northern sandplains and central wheatbelt than in species from the areas of higher rainfall in the south. The smallest seeds occur in members of sections *Cardiomyrthus* and *Verticilla* that are associated with swamps or watercourses in the far south-west.

Section *Verticilla* seems to be a relictual group, close to extinction. One of its two species may already be extinct and the other is known only from a single population. Presumably this group evolved during a period of higher rainfall than is currently found in south-western Australia, radiated to a significant degree, as evidenced by the many differences between the two known species, and then declined. Hopper and Gioia (2004: 636) noted that waterlogged or moisture-retaining soils in the south-west ‘provide habitat for the phylogenetically relictual taxa of the region’ with most of these taxa occurring in the high rainfall zones of the extreme south-west or eastwards along the south coast. *Hypocalymma* sect. *Verticilla* appears to fit this trend well.

### Phenology and breeding systems

The new species *H. verticillare* has an unusual autumn flowering period from March to May, a factor that may have delayed its discovery. The other species included in this revision tend to flower primarily in spring or summer, mainly from September to December, although two of them have been recorded in flower throughout the year.

The breeding systems of four species of *Hypocalymma* sect. *Cardiomyrthus* (*H. cordifolium*, *H. minus*, *H. myrtifolium* and *H. speciosum*) have been studied by one of us (GJK) in cultivation at Kings Park. All species had flowers adapted to outcrossing and did not set seed when manually self-pollinated.

### Insect associations

Solitary native bees, mostly *Leioproctus* species, have been recorded visiting *Hypocalymma* flowers, as has the European Honey-bee, *Apis mellifera* (Houston 2000). Other insect visitors may also play a role in pollination and there are also limited records of honeyeaters and the Honey Possum, *Tarsipes rostratus*, visiting *Hypocalymma* species (Brown *et al.* 1997).

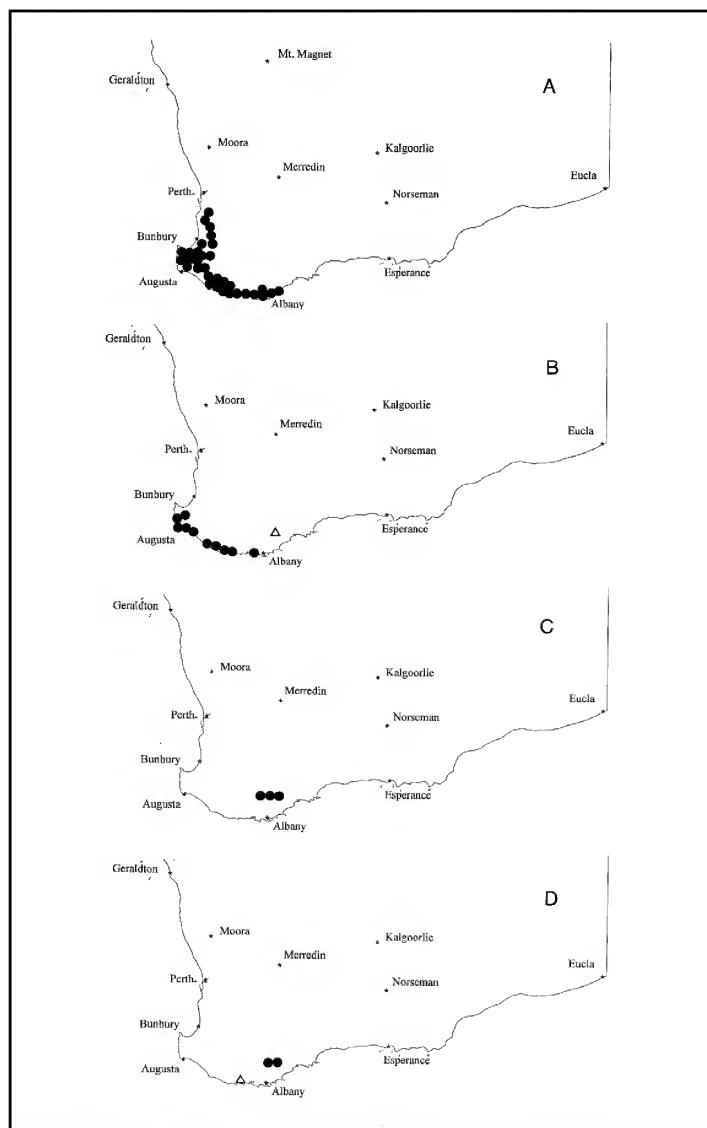


Figure 5. Distribution maps. A – *Hypocalymma cordifolium*; B – *H. minus* (●) and *H. myrtifolium* (△); C – *H. phillipsii*; D – *H. speciosum* (●) and *H. verticillare* (△).

### Granivorous insects

Granivorous bugs belonging to the family Lygaeidae seem to be particularly diverse and abundant in the seed litter under *Hypocalymma* species (Slater 1975, 1976), often forming large populations and with several species from varied genera sometimes found under a single shrub. They are also common under a number of legume and epacrid genera that have myrmecochorous seeds. Main (1981) suggested that the development of highly evolved elaiosomes leading to the removal of seeds by ants in such genera may have evolved as an effective defence against seed predation by lygaeid bugs. This could be the primary selection pressure for myrmecochory within Chamaeleuciaeae.

Although Berg (1975) lists no Myrtaceae as myrmecochorous, the presence of a fleshy aril on *Rinzia* (Trudgen 1986: Figure 2), *Ochrosperma* Trudgen and *Euryomyrtus* Schauer indicates that these genera are very likely to have ant-dispersed seeds. We are currently unsure how important ants are in the dispersal of *Hypocalymma* seeds and whether the seeds have a genuine reward for ants or just mimic the myrmecochorous seeds of genera with true elaiosomes (see Rye & Trudgen 2008). However, we do have direct evidence of myrmecochory in *Hypocalymma*. During the summer of 1986, one of us (GJK) observed workers of the ant species *Iridomyrmex purpureus* collecting fallen seeds of *H. myrtifolium* on Bluff Knoll. Ants have also been observed collecting seeds of *H. ericifolium* Benth. at Harvey.

### Scale-forming insects

*Hypocalymma* sect. *Cardiomyrthus* is host to many kinds of scale-forming insects that feed on sap, and these are most prevalent in *H. cordifolium*. The stems of *H. cordifolium* are commonly infested by the felt-scale genus *Callococcus* (Hemiptera family Eriococcidae). Male larvae produce small, felt-like covers at the nodes, while female larvae produce large, shell-like scales. *Callococcus* scales also occur commonly on species belonging to sect. *Hypocalymma* (Figure 2C) and on the two most closely related genera *Astartea* (Rye 2013: Figure 6A, B) and *Cyathostemon* but are unknown in any other members of the tribe Chamaeleuciaeae.

Several other kinds of scales observed on *H. cordifolium* occur on the leaves. Many are produced by white fly larvae (Hemiptera family Aleyrodidae), whose scales can be identified by the sculpturing of their surfaces, with lines, grooves and pits, and often also by the appearance of their waxy borders. One kind that is commonly observed on the undersurface of leaves is black with a narrow, shiny, white border. It is dorsiventrally very compressed and increases in size as the larva progresses through several stages (instars). The most mature scale commonly retains the empty scale of the previous instar, or even two previous instars (Figure 2D), on its dorsal surface. For convenience this structure is referred to here as a compound scale. It is also known on *H. phillipsii* but has not been found to date on any species of sections *Hypocalymma* and *Verticilla*, nor on any other members of the tribe, suggesting that it may be specific to sect. *Cardiomyrthus*.

Another kind of black scale, observed on only one specimen (J. Dewing 922) of *H. cordifolium* and also one specimen (G.J. Keighery 6192) of *H. myrtifolium*, seems to match the white fly scales that are common in *H. verticillare* of sect. *Verticilla* (Figure 2B). These scales are simple (i.e. the scales of previous instars are shed not retained) and tend to be smaller than the compound kind that is commonly found on *H. cordifolium*. They also differ in their location, occurring always near the edge of the leaf where they tend to be partially hidden by the recurved margin.

A much rarer scale, observed on only two specimens (e.g. R.F. Williams s.n. 16 Sep. 1932) of *H. cordifolium*, is pale brown with the body of the larva visible through the translucent scale (Figure 2E) and appears to be a coccid (Hemiptera family Coccoidea). No other members of the tribe Chamaeleuciaeae are known to have this kind of scale, but it is not as obvious as the black scales and would be more readily overlooked.

Another insect group (Hemiptera family Diaspididae) observed in *H. cordifolium* has a scale shaped more like a long tear drop, with the narrowed end pale brown and the rest white (Figure 2F). This diaspid is also known on *H. myrtifolium* but its occurrence on other members of the genus has not been investigated.

## Taxonomic relevance

The conspicuous, stem-attached *Callococcus* scales have been recorded on each of the three genera that constitute the *Astartea-Cyathostemon-Hypocalymma* clade of Wilson *et al.* (2004) but not on any other genera of Chamelaucieae, providing independent support for the clade. Some white flies are also highly host-specific (Woodward *et al.* 1970: 418), and the apparent restriction of the compound scale type to sect. *Cardiomyrthus* may provide additional evidence for the distinctiveness of this section. Other kinds of insects may also be significant, but a complete survey of their occurrence throughout the tribe Chamelaucieae is needed to determine whether or not they are of any value in suggesting taxonomic relationships between groups of taxa or in defining individual groups.

## Taxonomy

### Key to species with smooth or colliculate seeds

1. Young stems 3-angled, each angle with a rounded ridge that extends down from the base of the petiole above. Leaves in whorls of three, with oil glands in 2 or 3 main, irregular rows on each side of the midvein. Flowers solitary in the axils. Androecium of 15–26 filaments, united for at least half of their length (*Hypocalymma* sect. *Verticilla*)
  2. Leaf blades c. 7 × 1–1.5 mm. Petals 3.5–4 mm long, persistent in fruit. Anthers all of a similar size. Ovules multiple in each loculus (distribution unknown) ..... ***H. connatum***
  - 2: Leaf blades 3–6 × 1.8–2.3 mm. Petals 2–2.5 mm long, deciduous. Anthers very variable in size. Ovules solitary in each loculus (N of Walpole)..... ***H. verticillare***
- 1: Young stems all or mostly ± terete to 4-winged, the 4 angles or wings (when present) not aligned with the petioles. Leaves all or mostly opposite, dotted with numerous minute oil glands. Flowers up to 4 per axil, rarely all solitary. Androecium of 10–50 filaments, shortly united at the base or free (*Hypocalymma* sect. *Cardiomyrthus*)
  3. Leaves ovate to obovate to broadly elliptic, 15–40 mm long. Ovules horizontal, 6–12 per loculus. Seeds with hilum near base of inner surface
    4. Young stems and peduncles with minute hairs. Petals 6–9 mm long (Stirling Ra.) ..... ***H. phillipsii***
    - 4: Young stems and peduncles glabrous. Petals 4.5–6.5 mm long (eastern Stirling Ra.)..... ***H. myrtifolium***
  - 3: Leaves cordate or very broadly ovate to almost circular, 4–19 mm long. Ovules erect, 2 per loculus. Seeds with hilum near centre of inner surface.
    5. Petals deep pink-purple, 6–7 mm long. Ovary superior in flower.  
Seeds 1.6–1.7 mm long, minutely but distinctly colliculate (Stirling Ra.) ..... ***H. speciosum***
    - 5: Petals white or pale pink, 1.2–4.5 mm long. Ovary about half-inferior in flower.  
Seeds 0.8–1.3 mm long, smooth.
      6. Leaves cordate or depressed cordate, 6–19 mm long. Petals 2.5–4.5 mm long.  
Stamens 25–40, opposite petals as well as sepals. Mature style 2.5–5 mm long  
(Jarrahdale–Margaret River area–Cape Riche)..... ***H. cordifolium***
      - 6: Leaves ovate to cordate, 4–8(–10) mm long. Petals 1.2–2 mm long.  
Stamens 10–20, opposite sepals but not petals. Mature style 0.6–1.2 mm long  
(Whicher Ra.–Augusta–Denmark) ..... ***H. minus***

**Hypocalymma** sect. **Cardiomyrthus** Schauer, in J.G.C. Lehmann, *Pl. Preiss.* 1: 112 (1844). *Type*: *Hypocalymma cordifolium* Lehm. ex Schauer.

*Hypocalymma* sect. *Calocalymna* Turcz., *Bull. Soc. Bull. Soc. Imp. Nat. Moscou* 35(4): 325–326 (1862), *nom. inval.* *Type*: *Hypocalymma speciosum* Turcz.

*Shrubs* 0.1–1(–1.5) m high, commonly with multiple suberect stems from a woody base or with adventitious roots produced from prostrate stems. *Young stems* glabrous or with minute simple hairs, 4-angled (very rarely 3-angled in *H. minus*) or irregularly terete, sometimes with the angles slightly to very prominently winged. *Leaves* opposite and decussate (very rarely in whorls of 3 in *H. minus*). *Petioles* absent or short. *Leafblades* elliptic to cordate, thin, with recurved margins, dotted with numerous minute oil glands, discolorous, the pale green undersurface with more obvious oil glands than the much darker upper surface, glabrous throughout or with margins laciniate to ciliate. *Inflorescence* with 1–4 flowers per axil, most axils 2-flowered in most species but 1-flowered in *H. minus*. *Peduncles* up to 11 mm long but sometimes ± absent. *Secondary axes* (when present) up to 12 mm long. *Bracteoles* 2 per flower, broader and often longer than the bracts. *Pedicels* short or absent. *Hypanthium* shortly cup-shaped or more obconic, usually rugose. *Sepals* well developed but much shorter than petals, broad-based, obtuse, largely herbaceous but with a narrow petaline border. *Petals* 1.2–9 mm long, white to deep pink, narrowed or shortly clawed at base. *Staminodes* rare or absent. *Stamens* (10–)13–50, in 2 series forming a complete ring (but one series sometimes with few stamens) when numerous but all antisepalous when few (i.e. 10–20), the longest stamens in the outer series when numerous or those closest to the petals when few, united shortly at base or free. *Ovary* 3-locular, half- to fully superior, the superior part with 3 rounded lobes, not or scarcely ridged; ovules 2 or 6–12 per loculus. *Style* with base inset into a cylindrical depression in the summit of the ovary; stigma small, capitate or slightly peltate. *Fruits* thick-walled. *Seeds* crustaceous, usually ± ovoid to reniform; body unfacetted or somewhat facetted, whitish to medium brown, smooth or minutely colliculate, 0.8–1.7 mm long; inner protrusion large, forming a distinctly coloured zone on inner surface of seed distal to the hilum, usually also extending laterally along each side of hilum but not fully encircling it; hilum small, sub-basal to central. *Chaff pieces* much smaller than seeds.

*Size and distribution.* A group of five species, restricted to the extreme south-west of Western Australia, with three species occurring in the Stirling Range and the others extending from Jarrahdale south to Augusta and along the south coast east to Cape Riche.

*Etymology.* From the Greek *kardia* (heart) and the genus *Myrtus* L., referring to the heart-shaped leaves in this myrtaceous group. Heart-shaped leaves are rare in Chamelaucieae but occur in three of the five species of *Hypocalymma* sect. *Cardiomyrthus*, including the type species *H. cordifolium*.

*Affinities.* See notes under *H. sect. Verticilla*.

*Notes.* *Hypocalymma* sect. *Cardiomyrthus* is reinstated here. It is a relatively well known plant group, with at least four of its five species in cultivation by 1990 and with *H. cordifolium* also used in the cut-flower trade (Elliot & Jones 1990). Within the key to *Hypocalymma* in Blackall and Grieve (1980: 91), the four species of *H. sect. Cardiomyrthus* that had been named by that stage are accurately keyed and illustrated.

Very little fruiting material is available for the three species from the Stirling Range but they all appear to have crustaceous chaff pieces of a similar colour to, or paler than, the seeds.

***Hypocalymma cordifolium*** Lehm. ex Schauer, in J.G.C. Lehmann, *Pl. Preiss.* 1: 112 (1844). *Hypocalymma cordifolium* Schauer subsp. *cordifolium* in Strid & Keighery, *Nord. J. Bot.* 22: 565 (2002). *Type*: Albany, Western Australia, October 1840, L. Preiss 154 (*lecto*: LD, *fide* A. Strid & G.J. Keighery, *Nord. J. Bot.* 22: 565 (2002); *isolepto*: K, KW, MEL, S, W).

*Illustrations*. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildflowers* 3A: 91, n. 9 (1980); J.R. Wheeler, N.G. Marchant & M. Lewington, *Fl. South West* 2: 707 (2002).

*Shrub* up to 1 m high, single-stemmed at base where known. *Young stems* prominently 4-winged, sometimes becoming deep red; wings patent, extending the length of each internode, tending to be broadest at the apex and extending laterally from the petioles or leaf base directly above, alternating in direction at successive internodes in a decussate arrangement, commonly 0.5–1.2 mm wide, often ciliate to lacinate. *Petioles* absent or up to c. 0.5 mm long. *Leaf blades* mostly patent, cordate, 6–19 mm long, 9–18 mm wide, acute or obtuse, often distinctly ciliate; apical point absent or poorly defined, up to 0.3 mm long; midrib indented on upper surface and prominent on lower surface. *Inflorescence* occupying 1–16 nodes per branchlet. *Peduncles* 1–4-flowered, up to 11 mm long if 1-flowered, up to c. 5 mm long but with long secondary axes if multi-flowered. *Secondary axes* 4–11 mm long. *Bracteoles* deciduous or persistent, linear or narrowly obovate, 1.3–2 mm long, green or red-tinged. *Pedicels* absent or up to 1.3 mm long. *Flowers* 7–11 mm diam. *Hypanthium* strongly rugose-pitted or smoother but glandular. *Sepals* broadly oblong-elliptic to depressed ovate, 1.5–2 mm long, 1.9–2.3 mm wide, the herbaceous part green or red-tinged; petaline margin c. 0.3 mm wide, usually white and tinged deep pink. *Petals* 2.5–4.5 mm long, white or pale pink, deciduous. *Stamens* 25–45, united at base in a full circle opposite petals as well as sepals. *Longest filaments* 2–4 mm long, united for up to 0.5 mm at base. *Anthers* 0.2–0.3 mm long. *Ovary* c. half-inferior; ovules 2 per loculus, erect. *Style* 2.5–5 mm long. *Fruits* at least half-superior, 1.5–1.7 mm long. *Seeds* 1.1–1.3 mm long, 0.5–0.6 mm wide, 0.6–0.7 mm deep, off-white (pearly) or pale brown, smooth; inner protrusion 0.4–0.6 mm long, 0.2–0.5 mm deep, white or off-white; hilum at centre of inner surface. *Chaff pieces* membranous, very compressed, darker than the seeds. (Figure 2A)

*Selected specimens examined*. WESTERN AUSTRALIA: Samson Brook transect, 26 Sep. 2000, R.R. Archer 124 (PERTH); 30 km NNE of Albany, between Bettys Beach and NE side of Two Peoples Bay, 26 Sep. 2004, R.K. Brummitt, A.S. George & E.G.H. Oliver 21358 (PERTH); 14.2 km E of Sues Rd on Crouch Rd, 21 Nov. 2008, G.J. & B.J. Keighery 1422 (PERTH); 500 m W of corner of Swarbrick and Osmington Rds, E of Margaret River, 23 Aug. 2007, M. Morley 115 (PERTH); W end Lake Powell Nature Reserve, c. 100 m S of end of Hassell Rd, 20 Nov. 2007, E.M. Sandiford & D.A. Rathbone 1386 (PERTH).

*Distribution and habitat*. Extends from Jarrahdale south to near Margaret River and along the south coast east to Cape Riche (Figure 5A), in damp habitats, mainly associated with swamps or watercourses.

*Phenology*. Flowers all year but mainly September to November. Fruits mainly recorded November to January.

*Conservation status*. Not considered to be at risk. This species is widely cultivated as well as being the most widespread species in its section.

*Affinities*. Very similar to *H. minus*, as discussed under that species.

*Notes.* *Hypocalymma cordifolium* is the most variable species in sect. *Cardiomyrtus*. Cultivars of *H. cordatum* include one with variegated leaves. Flower size in natural populations is very variable, with the smallest flowers of a similar size to the largest flowers found in *H. minus*. Anther morphology is also variable, and sometimes the thecae become latrorse and curved rather than being straight and parallel.

*Hypocalymma cordifolium* may be a particularly important host plant for Hemipterous species that feed on sap (see *Insect associations* section above). Seed-eating bugs belonging to the genera *Botocudo* and *Isopeltis* (Hemiptera family Lygaeidae) have been recorded in its seed litter (Slater 1975).

Several of the specimens cited for this taxon by Strid and Keighery (2002), as subsp. *cordifolium*, have now been re-identified as *H. minus*. These are cited below.

***Hypocalymma minus* (Strid & Keighery) Keighery, stat. et comb. nov.**

*Hypocalymma cordifolium* subsp. *minus* Strid & Keighery, *Nord. J. Bot.* 22: 567–568 (2002). *Type:* by Brennans Ford, Scott River Crossing, east-north-east of Augusta, Western Australia, 16 November 1982, A. Strid 21416 (*holo*: C; *iso*: B, G, MEL, MO, PERTH 1175823 & 1945165).

*Hypocalymma* sp. Scott River (A.S. George 11773), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed March 2013]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 387 (2000); J.R. Wheeler, N.G. Marchant & M. Lewington, *Fl. South West 2*, 708 (2002).

*Illustration.* J.R. Wheeler, N.G. Marchant & M. Lewington, *Fl. South West 2*: 708 (2002) as *Hypocalymma* sp. Scott River (A.S. George 11773).

*Shrub* usually 0.1–0.4 m high, almost prostrate or low-growing, sometimes layering from decumbent or prostrate stems. *Young stems* slightly to prominently 4-winged (rarely with some stems 6-winged); wings patent, extending the length of each internode, tending to be broadest at the apex and extending laterally from the petioles or leaf base directly above, alternating in direction at successive internodes in a decussate arrangement, commonly 0.2–0.5 mm wide, sometimes ciliate. *Petioles* 0.1–0.5 mm long. *Leaf blades* mostly patent, ovate to cordate, rarely all cordate, 4–8(–10) mm long, 3–9 mm wide, acute or obtuse, often distinctly ciliate; apical point up to 0.3 mm long, white. *Inflorescence* occupying 1 to many nodes per branchlet. *Peduncles* 1-flowered, 4–11 mm long. *Bracteoles* deciduous or persistent, narrowly ovate to ± narrowly elliptic or ovate, 0.7–1.5 mm long, rather scarious, green or red-tinged. *Pedicels* absent. *Flowers* commonly 4–6 mm diam. *Hypanthium* rugose or glandular. *Sepals* very broadly or depressed ovate to almost semicircular, 0.6–1.3 mm long, 1–1.6 mm wide, the herbaceous part green or red-tinged; petaline margin c. 0.3 mm wide, white or tinged deep pink. *Petals* 1.2–2 mm long, white, deciduous. *Stamens* 10–20, opposite sepals but not petals, all or mostly free. *Longest filaments* 0.5–1 mm long, free or united for up to 0.2 mm at base. *Anthers* 0.2–0.3 mm long. *Ovary* c. half-inferior; ovules 2 per loculus, erect. *Style* 0.6–1.2 mm long. *Fruits* at least half-superior, 1.3–1.5 mm long. *Seeds* 0.8–1.1 mm long, c. 0.5 mm wide, c. 0.6 mm deep, off-white (pearly) or pale brown, smooth; inner protrusion 0.4–0.5 mm long, c. 0.2 mm deep, white or off-white; hilum at centre of inner surface. *Chaff pieces* membranous, very compressed, darker than the seeds.

*Selected specimens examined.* WESTERN AUSTRALIA: Sandy Track, D'Entrecasteaux National Park, 23 Dec. 2002, R.J. Cranfield 18736 & L. Sage (PERTH); Black Point, D'Entrecasteaux National Park, 31 Oct. 1990, N. Gibson & M. Lyons 989 (PERTH); 14.2 km E of Sues Rd on Crouch Rd, 21 Nov. 2008, G.J. & B.J. Keighery 1423 (PERTH); 600 m S along track from Chesapeake Rd, 3 Nov.

2009, *J. Liddelow* 107 (PERTH); Augusta townsite, 8 June 1989, *G. McCutcheon* 2078 (PERTH); on walking track down to the beach from the car park at the end of Crusoe Beach Rd, Rudgway Nature Reserve, 6 Jan. 2010, *B.L. Rye* 290125 (PERTH); c. 200 m NW of Railway Parade, W of Walpole, 25 Apr. 2008, *M. Sowry* 109 (PERTH).

**Distribution and habitat.** Occurs in the extreme south-west corner of the State and extends along the south coast east to the Denmark area (Figure 5B) in winter-wet to damp, often skeletal loams over an impeding layer, often under a *Taxandria linearifolia* shrubland.

**Phenology.** Flowers and fruits all year.

**Conservation status.** This species is not considered to be at risk as it has a range c. 250 km long and is known from many localities, including populations that are protected within national parks and other reserves.

**Affinities.** Previously treated as a subspecies of *H. cordifolium* but distinguished by its normally prostrate habit, slender stems, smaller leaves, smaller flowers and fewer stamens.

During a survey of plant communities on the Blackwood Plateau in 2008 by one of the current authors (GJK) and Bronwen Keighery, a large co-occurrence of the two subspecies of *H. cordifolium* was located. This locality showed ecological separation of the two taxa, subsp. *minus* (G.J. Keighery & B.J. Keighery 1421) occurring mainly on shallow, winter-wet, red, clay loams over ironstone and subsp. *cordifolium* (G.J. Keighery & B.J. Keighery 1422) on deeper soils along the adjacent creek. However, numerous plants grew side by side within this area and, despite careful searching, no signs of intergradation or hybridisation were detected. This strongly suggested that these were two species, not subspecies; consequently subsp. *minus* is here raised to specific status.

**Notes.** There is some tendency for the leaves to be ovate on young plants and become more cordate as the plant matures, but some mature specimens retain ovate leaves and some specimens may have even the young leaves cordate.

***Hypocalymma myrtifolium* Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersburg* 10: 333 (1852). Type:** ‘Nova Hollandia’ [Stirling Range, Western Australia], 1848, *J. Drummond* 5: 118 (*holo*: KW 001001304; *iso*: BM, G, K 000797335, 000797331–3, MEL, NSW 456459, PERTH 01637207, W).

***Hypocalymma hypericifolium* Benth., *Fl. Austral.* 3: 95 (1867). Type:** Swan River Colony [Stirling Range, Western Australia], 1848, *J. Drummond* 5: 118 (*lecto*: K 000797335, here selected; *isolecto*: BM, G, K 000797331–3, KW 001001304, MEL, NSW 456459, PERTH 01637207, W).

**Illustration.** W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildflowers* 3A: 91, n. 12 (1980).

**Shrub** 0.3–0.8 m high, often multi-stemmed from a woody base or lignotuber. **Young stems** glabrous, 4-angled and often somewhat winged; wings up to 0.4 mm wide, sometimes serrulate. **Petioles** absent. **Leaf blades** antrorse or patent, ovate to obovate or broadly elliptic (usually ± elliptic), 15–40 mm long, 6–16 mm wide, acute or obtuse, serrulate, sometimes with an apical point up to 0.4 mm long; midrib indented on upper surface and prominent on lower surface. **Inflorescence** occupying 1–10 nodes per branchlet. **Peduncles** very reduced, mostly 2-flowered. **Secondary axes** 1–2.5 mm long. **Bracteoles** fairly persistent, very broadly or depressed ovate, 1.5–2.3 mm long, obtuse, green or red-

tinged. *Pedicels* absent or very reduced. *Flowers* 13–15 mm diam. *Hypanthium* glandular and rugose-pitted, green. *Sepals* very broadly ovate to elliptic, 2–3.5 mm long, 1.8–2.8 mm wide, the herbaceous part usually green; petaline margin 0.3–0.4 mm wide, white or red-tinged. *Petals* 4.5–6.5 mm long, white, persistent. *Stamens* 30–50 in 2 series forming a complete circle. *Longest filaments* 3.5–4.5 mm long, united for c. 0.6 mm at base. *Anthers* 0.4–0.7 mm long. *Ovary* c. half-inferior; ovules 6–10 per loculus, horizontal. *Style* 3–4 mm long. *Fruits* over half-superior, c. 3 mm long. *Seeds* 1.3–1.4 mm long, 0.5–0.6 mm wide, 0.8–0.9 mm deep including inner protrusion, pale brown or becoming medium brown, smooth; inner protrusion 0.8–1 mm long, 0.2–0.3 mm deep; hilum towards base of inner surface. *Chaff pieces* crustaceous. (Figure 4B)

*Selected specimen examined.* WESTERN AUSTRALIA [locality withheld for conservation reasons]: 31 Oct. 1994, A. Worz 04.10.31.01 (PERTH).

*Distribution and habitat.* Restricted to the eastern peaks of the Stirling Range (Figure 5B), on lower rocky slopes to near the summits of mountains.

*Phenology.* Flowers July to November. Seeds were present on specimens collected in October and November, but these were possibly not fully mature in their colour.

*Conservation status.* Recently listed as Priority Two under the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–) [now the Department of Parks and Wildlife]. No collections have been made of *H. myrtifolium* since 1994. All populations occur in a large national park but the known range of the species is only about 10 km long. Many plant species from this park, although protected from clearing, are still highly threatened if they are susceptible to attack by the water mould *Phytophthora*. The susceptibility of species of sect. *Cardiomysrtus* to this pathogen is unknown.

*Affinities.* Very similar to *H. phillipsii*, differing mainly in the absence of hairs on the stems and peduncles and in its usually smaller flowers. *Hypocalymma myrtifolium* also tends to have narrower sepals and its leaves show a greater tendency to be obovate, acute and less prominently pointed than in *H. phillipsii* but there are no absolute differences in these characters. The two taxa are geographically separated, with *H. phillipsii* extending from the western peaks to the south-eastern peaks of the Stirling Range but absent from the north-eastern peaks where *H. myrtifolium* is found.

A comparison of *H. phillipsii* and *H. myrtifolium* using molecular data would be useful to examine how closely related they are, as it is possible they should be regarded as subspecies rather than species. More fruiting material is also needed to determine whether differences observed in the few seed samples examined of the two taxa are significant. The single specimen with seeds from *H. phillipsii* differed from two seeding specimens of *H. myrtifolium* in having darker seeds with a thicker inner protrusion.

*Typification.* There are four Drummond sheets at Kew, one stamped ‘Herbarium Benthamianum 1854’, two stamped ‘Herbarium Hookerianum 1867’, and one ex herb. W.W. Saunders with a sticker saying it was ‘Presented by the Linnean Society, 1915’. All sheets have ample flowering material and are annotated in the same hand. There is no certainty that Bentham had only one of these available to him when he drew up his descriptions for *Flora Australiensis*. We therefore consider it necessary to choose a lectotype for *H. hypericifolium* and have selected the specimen indicated as ex Herbarium Benthamianum since it has clear links to Bentham and already bears relatively recent Kew type labels.

*Notes.* This was one of two Stirling Range species of *Hypocalymma* collected originally by James Drummond, who described them in a letter dated 29 October 1848. He recorded the species now known as *H. myrtifolium* as growing in the woods at the eastern end of one of the mountains of the Stirling Range and stated ‘a faithful drawing of which, leaves, flowers and branches might very well pass for the broad leaved Indian Myrtle’ (Drummond 1839–1848).

***Hypocalymma phillipsii*** Harv., *Nat. Hist. Rev.* 5(2): 296, t. 22 (1858). *Type:* cultivated in Botanic Garden of Dublin from seeds collected in neighbourhood of King George Sound, Western Australia (*holo:* TCD; *iso:* MEL 104609).

*Illustrations.* W.H. Harvey, *loc. cit.* (1858); W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildflowers* 3A: 91, n. 11 (1980).

*Shrub* commonly 0.4–1 m high but recorded up to 1.5 m, erect or sprawling, up to at least 1.5 m across, often producing multiple erect stems from a lignotuber. *Young stems* somewhat 4-angled or slightly 4-winged to elliptic in cross-section or terete, with a very dense indumentum; hairs patent, up to 0.4 mm long, white or pale brown, obtuse. *Petioles* absent. *Leaf blades* mostly antrorse but some (especially those subtending flowers) patent, elliptic to very broadly ovate, 15–40 mm long, 8–20 mm wide, usually obtuse, serrulate, rarely with an apical point 0.3–0.5 mm long; midrib indented on upper surface and prominent on lower surface. *Inflorescence* occupying 1–4 or rarely up to 9 nodes per branchlet. *Peduncles* absent or very reduced, up to c. 1 mm long, mostly 2-flowered. *Secondary axes* 1–7 mm long, with a moderately dense indumentum of simple, patent hairs up to 0.2 mm long. *Bracteoles* persistent, broadly or very broadly ovate, 1.5–3 mm long, obtuse. *Pedicels* absent or very reduced. *Flowers* mostly 14–18 mm diam. *Hypanthium* rugose and glandular, each gland often in a broad pit, usually green except for a reddish summit. *Sepals* very broadly ovate to elliptic, 2–3.5 mm long, 2.5–3.5 mm wide, the herbaceous part green and red-tinged or reddish throughout; petaline margin 0.3–0.7 mm wide, usually white at apex and tinged deep pink below. *Petals* 6–9 mm long, white, persistent. *Stamens* 30–50 in 2 complete series. *Longest filaments* 4–6 mm long, united for c. 0.5 mm at base. *Anthers* 0.4–0.7 mm long. *Ovary* c. half-inferior or more than half-superior; ovules 6–12 per loculus, horizontal. *Style* 4–6 mm long. *Fruits* over half-superior, 3–4.3 mm long. *Seeds* 1.3–1.6 mm long, 0.5–0.6 mm wide, 0.9–1.1 mm deep including inner protrusion, medium brown, smooth; inner protrusion 0.8–1.1 mm long, 0.2–0.4 mm deep; hilum towards base of inner surface. *Chaff pieces* crustaceous.

*Selected specimens examined.* WESTERNAUSTRALIA [localities withheld for conservation reasons]: 6 Nov. 2003, S. Barrett 1156 (PERTH); 20 Nov. 2004, S. Barrett 1182 (PERTH); 13 Oct. 2005, S. Barrett 1426 (PERTH); 3 Jan. 2003, J.A. Cochrane 4438, A. Crawford & J. Wood (K, PERTH); 20 Oct. 2002, M. Hislop 2840 (AD, PERTH).

*Distribution and habitat.* Occurs in the western, central and south-eastern parts of the Stirling Range (Figure 5C), on rocky slopes or summits of mountains.

*Phenology.* Flowers from September to November. Mature seeds recorded in December and January. The leaves tend to turn reddish during summer.

*Conservation status.* Priority Three under DEC Conservation Codes for Western Australian Flora (Smith 2012). Known from many localities, all within a large national park, including some recent collections, over a range c. 45 km long.

*Affinities.* This taxon possibly should be treated as a subspecies of *H. myrtifolium* (see notes under that species). *Hypocalymma phillipsii* can be readily recognised, however, as it is the only member of sect. *Cardiomyrthus* to have hairs on its young stems. Some species of sect. *Hypocalymma* also have hairy stems but their hairs are often compressed, longer and acute, and they may also be branched.

*Notes.* While there are normally two flowers in an axil in *H. phillipsii*, there is no clear peduncle and the axis may grow out between the two flowers, which then appear to be solitary on each side of the new axis, each subtended by a small leaf-like bract or reduced leaf as well as the large main subtending leaf.

***Hypocalymma speciosum*** Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersburg* 10: 332 (1852). *Type:* ‘Nova Hollandia’ [Stirling Range, Western Australia], 1848, *J. Drummond* 5: 119 (*holo*: KW; *iso*: BM 00105087, K 000797331, MEL 104628, 104629, PERTH 01829599).

*Hypocalymma boroniaceum* F.Muell. ex Benth., *Fl. Austral.* 3: 95 (1867). *Type:* Swan River Colony [Stirling Range, Western Australia], 1848, *J. Drummond* 5: 119 (*lecto*: K 000797331, here selected; *isolecto*: BM 00105087, K, KW, MEL 104628, 104629, PERTH 01829599).

*Illustration.* W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildflowers* 3A: 91, n. 10 (1980).

*Shrub* 0.25–0.7 m high, often producing multiple erect stems from a lignotuber. *Young stems* 4-angled and somewhat 4-winged, glabrous; wings up to 0.4 mm wide. *Petioles* ± absent. *Leaf blades* antrorse or patent, cordate or ovate or circular, 4–18 mm long, 7–15 mm wide, ± entire; midrib level on upper surface and not very prominent on lower surface. *Inflorescence* commonly occupying 3–8 adjacent nodes on each branchlet. *Peduncles* almost absent or up to 1.5 mm long, 1–4-flowered, often pendulous. *Secondary axes* 6–12 mm long. *Bracteoles* usually deciduous, obovate in outline, 2–3.3 mm long, obtuse, somewhat scarious. *Pedicels* absent or very reduced. *Flowers* mostly 10–12 mm diam. *Hypanthium* markedly rugose-pitted, green or red-tinged. *Sepals* broadly elliptic, 2–3.8 mm long, 2.3–2.7 mm wide, with a green or reddish, rugose herbaceous part; petaline margin 0.3–0.5 mm wide, white, tinged with red. *Petals* 6–7 mm long, deep pink-purple, persistent. *Stamens* 25–40 in 2 series, forming a complete ring. *Longest filaments* 3.5–4.5 mm long, united at base for c. 0.3 mm. *Anthers* c. 0.4 mm long. *Ovary* superior, often pinched in at base; ovules 2 per loculus, erect. *Style* 3–4 mm long. *Fruits* superior, c. 3 mm long. *Seeds* c. 1.65 mm long, c. 0.5 mm wide, c. 1 mm deep, very pale brown, minutely colliculate; inner protrusion c. 1.2 mm long, c. 0.35 mm deep; hilum slightly below middle of seed. *Chaff pieces* crustaceous.

*Selected specimen examined.* WESTERN AUSTRALIA [locality withheld for conservation reasons]: 13 Dec. 1988, R.T. Wills 970 (PERTH).

*Distribution and habitat.* Occurs in rocky soils in the central and western parts of the Stirling Range (Figure 5D). *Hypocalymma speciosum* overlaps in range with both *H. phillipsii* and *H. myrtifolium* and seems to occur in similar habitats so it possibly sometimes grows with them.

*Phenology.* Flowers from September to December. Mature fruits recorded in December.

*Conservation status.* Recently listed as Priority Two under DEC Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–). No collections have been made of *H. speciosum* since 1994 but its distribution is well known from earlier collections. Its localities are scattered over a distance of at least 35 km, all within a large national park.

*Affinities.* This species is very distinctive. It shares some morphological characters with the other two species that occur in the Stirling Range and the molecular data suggest that its relationship lies with them (see Figure 1). However, it is keyed out with the geographically distinct species *H. cordifolium* and *H. minus* as it is similar to them in leaf shape and ovule number. The ovary is almost fully superior in *H. speciosum*; the superior part is about 2 mm long and usually pinched in below the fully superior ovules, with only the sterile base being adnate to the short hypanthium. The superior ovary of *H. speciosum* is unique in the Chamaeleae; most members of the tribe have a fully or largely inferior ovary, while others, including the other four members of sect. *Cardiomyrthus*, have a more or less half-inferior ovary.

*Typification.* Bentham cited two syntypes for *Hypocalymma boroniaceum*: a primary one collected by Drummond and a secondary one collected by Dutton. There are three Drummond duplicates at Kew, one stamped ‘Herbarium Benthamianum 1854’, one stamped ‘Herbarium Hookerianum 1867’, and one ex herb. W.W. Saunders with a sticker saying it was ‘Presented by the Linnean Society, 1915’; all sheets have ample flowering material. Duplicates in BM and G bear no evidence of examination by Bentham. At MEL, there is one Drummond sheet (MEL 104628) as well as the Dutton collection (MEL 104629); only the Dutton collection is marked to indicate that it was sent to Bentham. For the same reasons given under *H. hypericifolium*, we have chosen the specimen ex Herbarium Benthamianum as lectotype.

*Notes.* James Drummond was sufficiently impressed by this species to describe it in a letter to G. Leake on 29 October 1948 as ‘a beautiful species of the *Cardiomyrthus* section of the genus which I observed on the Toolbrunup Hills’ (Drummond 1839–1848).

*Hypocalymma speciosum* has deeply coloured, pink-purple flowers, which are often pendulous. Pollinator observations of this taxon are needed to assess the function of these characters. The apparent length of the style is increased by its position on the superior ovary.

More fruiting collections with mature seeds are needed for this species as only one mature seed has been seen so far.

#### ***Hypocalymma* sect. *Verticilla* Rye, *sect. nov.***

Fruticuli pusilli. Caules juvenes 3-angulati, 3-porcati, verticillis 3-foliatis. Flores solitarii e foliorum summorum axillis orientes. Pedunculi longi. Bracteolae 2, oppositae, deciduae. Petala 5, sepala multi superantia. Stamina plerumque 17–25, pro longitudine plus dimidium in circulum completum conjuncta, saepe longa et brevia alternata. Filamenta compressa, apicem versus decrescentia. Antherae basifixae, dehiscentia parallela longitudinali; glans connectiva simplex, dorsalis et subterminalis. Ovarium 3-loculare; ovula 1–10 per loculum. Styli basis in depressionem cylindricum immersa. Fructus: capsula 3-valvata, c. 1/2 inferior. Semina crustacea, corpo ad basim lato, ad apicem angustiore in dimidio distali tumore elaisomo expanso, 1–1.3 mm longa, alba vel brunnea.

*Typus:* *Hypocalymma verticillare* Rye.

*Shrubs* (where known) 0.2–0.8 m high, single-stemmed, with very slender stems. *Leaves* in alternating whorls of three, antrose to patent, mostly widely spreading. *Petioles* short but well defined. *Leaf blades* discolored, small, with recurved to revolute margins; abaxial surface pale green, oil glands in several main rows on each side of a prominent midvein; adaxial surface significantly darker green

than abaxial surface, with oil glands inconspicuous. *Flowers* solitary in the upper leaf axils, pendulous. *Peduncles* long, 1-flowered. *Bracteoles* 2, opposite, caducous or deciduous, small and very narrow, entire, inconspicuous. *Pedicels* much shorter than peduncles. *Hypanthium* with adnate part conic and free part often becoming ± flat. *Sepals* 5, erect, persistent in fruit, entire, not or somewhat ridged along middle of the more herbaceous part. *Petals* 5, spreading or erect, deciduous or persistent in fruit, almost circular, shortly clawed, white or possibly sometimes pink. *Staminodes* absent or up to 5. *Stamens* c. 17–23 united into a broad cylinder that contracts (becomes narrower) towards the top, the longest stamens either tending to be opposite the sepals or not showing any particular position with respect to the sepals and petals but always tending to alternate with short stamens around the circle, sometimes with anthers of very different sizes present. *Filaments* united for about half to all of their length, very compressed where united into the ring and either compressed or very narrow where free. *Anthers* sub-basifix; cells free from one another, parallel, longitudinally dehiscent; connective gland simple, dorsal and subterminal. *Ovary* partly superior, 3-locular, summit hidden from side view by the androecium; placentas axile, sessile, broadly elliptic to circular, broadly attached at centre; ovules solitary and erect or up to 10 per loculus and radially arranged. *Style* terete, slender, with base immersed in a cylindrical depression at centre of ovary; stigma capitate or peltate. *Fruits* about half-inferior where known, surrounded by the persistent androecium, thick-walled; valves rounded, usually rugose. *Seeds* often many per fruit, crustaceous, the body ovoid-reniform, i.e. broader below the middle, but upper part expanded by an inner protrusion, 1–1.3 mm long, smooth, shiny; inner protrusion distal to the hilum, whitish; hilum towards base of inner surface. *Chaff pieces* scarcely known, sometimes absent.

*Size and distribution.* A section of two species, endemic to Western Australia, with an incompletely known range in the far south-west of the State. *Hypocalymma verticillare* is recorded from north of Walpole, occurring near the margin of a wetland in a region of very high rainfall. Like that species, *H. connatum* has discolored leaves, a character that occurs in some species of Chamaeleaceae from the wettest parts of the south-west but is virtually unknown in areas of moderate rainfall. One possibility recorded in a note on the ‘rare file’, dated 1995, is that *H. connatum* came from the Katanning–Cranbrook–Tambellup area on the train line, one of the likely sources of plants for a wildflower show in the 1930s.

*Etymology.* From the Latin *verticillus* (whorl, circle), referring to the whorled leaves of this section.

*Notes.* The rather large degree of morphological separation of the two known species suggests that much greater variation may have existed when sect. *Verticilla* reached its peak of speciation long ago. Nevertheless there are striking similarities between the two species described below and they are very readily distinguished from the other sections of *Hypocalymma* (see Table 1). Unique characteristics of sect. *Verticilla* include its 3-angled young stems with three rounded ridges and its regularly whorled leaves. It is also unusual in its rather pendulous flowers and fruits, a character also found in one species (*H. speciosum*) of sect. *Cardiomyrtus*. How this character relates to pollination needs to be investigated.

***Hypocalymma connatum*** Strid & Keighery, *Nord. J. Bot.* 22: 572. *Type:* Wildflower Show, Perth, Western Australia, September 1935, C.A. Gardner s.n. [original locality and collector unknown] (*holo*: PERTH 04231457).

*Shrub* height unknown but at least 0.4 m. *Young stems* with internodal ridges that are c. 0.6 mm thick at summit; minor lateral branchlets strongly compressed up to the first node but obviously 3-ridged above this node. *Leaves* moderately antrorse to patent. *Petioles* c. 0.5 mm long. *Leaf blades* narrowly ovate, 6–7 mm long, 1–1.5 mm wide, acute, with strongly recurved or revolute margins, often with a

pale triangular apical point up to 0.5 mm long; abaxial surface with 2 or 3 main rows of usually 8–15 oil glands on each side of the midvein. *Inflorescence* occupying 1 or 2 nodes per branchlet. *Peduncles* strongly curved at base to be pendulous in fruit, 1-flowered, 3–4 mm long, somewhat compressed. *Bracteoles* apparently very small. *Pedicels* 0.7–1 mm long. *Flowers* not seen at anthesis but probably pendulous, certainly becoming pendulous. *Hypanthium* c. 1.5 mm long and 4.5 mm diam. in fruit, irregularly narrowly wrinkled longitudinally and with oil glands visible; free portion apparently absent in fruit. *Sepals* very broadly or depressed ovate, 2–2.5 mm long, up to c. 3.2 mm wide, broadly obtuse, somewhat ridged in bud but not at all ridged in fruit; thin-textured margin narrow, whitish or red-tinged. *Petals* 3.5–4 mm long, probably white, persistent, erect in fruit. *Stamens* c. 17. *Longest filaments* c. 3 mm long, united for half or over half their length, the free part flattened but tapering to a narrow apex. *Anthers* all fertile, all of a similar size in each flower, the smallest c. 0.35 mm long, the largest c. 0.4 mm long. *Style* 3.5–4 mm long; stigma capitate, c. 0.2 mm diam. *Ovary* probably largely inferior; ovules reportedly 3 or 4 but probably 8–10 per loculus. *Fruits* half-inferior, c. 3.5 mm long, c. 4.5 mm diam. *Seeds* 1–1.1 mm long, c. 0.5 mm wide, 0.5–0.6 mm thick, medium brown; inner protrusion extending down from top of seed for more than half the length of the seed body, c. 0.75 mm long, c. 0.25 mm deep, whitish. (Figures 4C, 6)

*Distribution and habitat.* Unknown, but presumably the species occurs either in a similar high-rainfall area to, or in a slightly drier area than, *H. verticillare* (see under *Size and distribution* above).

*Phenology.* Mature fruits recorded in September.

*Conservation status.* Priority One under DEC Conservation Codes for Western Australian Flora (Smith 2012). Being known from a single old collection of unknown locality, this species was presumed by Strid and Keighery (2002) to be extinct.

*Affinities.* Strid and Keighery (2002) thought their new species was probably related to *H. myrtifolium* Turcz., a member of the sect. *Cardiomyrtus*. Now the newly described species *H. verticillare* is known to be a much closer match in its morphology to *H. connatum*.

*Notes.* The habit of *H. connatum* is unknown, but the plant sampled was likely to have been at least 0.4 m high as that was the length of the apparently erect branch mounted on the herbarium sheet. Bracteoles had fallen from the few late flowers and fruits that were in a packet attached to the sheet, but there was a very short, apparently shrivelled structure c. 0.35 mm long at the top of the peduncle of the single flower left attached to the mounted branch. It seems likely that bracteoles would normally be larger, so this measurement was not given in the description above. Although the fruits were empty, some seeds and one piece of chaff were preserved in a packet.

Adding to the mystery surrounding the origin of this plant are the notes and illustration of morphological characters provided on the specimen by Charles Gardner (Figure 6). Notes indicate that there are '3 or 4 ovules in each cell app. collateral' and these are drawn as being erect. In fact, there appear to be eight to ten ovules in each cell, judging from the number of attachment points on the placentas in the fruits and from the number of indentations formed by seeds inside the fruit wall of each loculus. Perhaps the particular fruit examined by Gardner had most of the seeds already dispersed and only three or four seeds were left, giving the impression that the ovule number was low.

Seeds of *H. verticillare* are fully erect, solitary, off-white and fairly smooth but not particularly shiny, whereas those of *H. connatum* are more numerous, probably closer to horizontal,

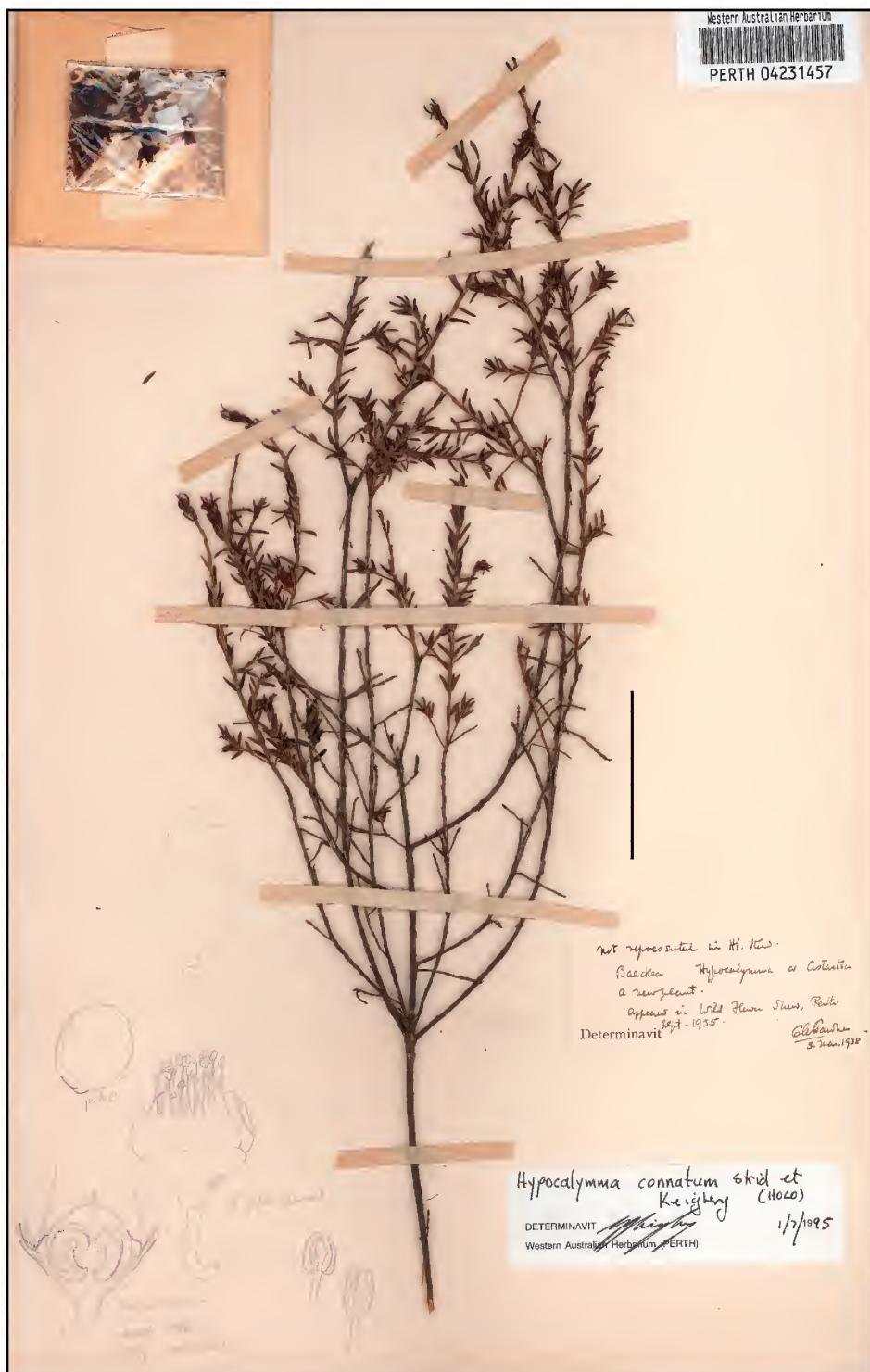


Figure 6. Holotype of *Hypocalymma connatum*. Scale bar 5 cm.

medium brown, very smooth and very shiny. Chaff pieces are apparently absent or few in *H. connatum* as only one could be found in the loose seed sample on the holotype; also, the depressions in the fruit wall suggest that it is mostly seeds that have been produced. The single chaff piece examined was compressed but crustaceous, and most of its surface was darker than the seeds although its very reduced inner protrusion was paler.

***Hypocalymma verticillare* Rye, sp. nov.**

*Hypocalymmate connato affinis sed foliis minoribus latioribusque, floribus minoribus, staminibus magis variabilibus, ovulis in quoque loculo solitariis et stigmate peltato differt.*

*Typus*: north-east of Walpole, Western Australia [precise locality withheld for conservation reasons], 12 May 2005, B.L. Rye 250504 & E.D. Middleton (holo: PERTH 07131232; iso: CANB, K, MEL, NSW).

*Hypocalymma* sp. Walpole (E.D. Middleton EDM 33), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed March 2013].

*Shrub* 0.2–0.8 m tall, single-stemmed at base, much branched above, with slender stems. *Young stems* with ridges c. 0.3 mm thick at top end. *Leaves* very widely antorse or patent. *Petioles* 0.3–0.5 mm long. *Leaf blades* ovate to elliptic or becoming narrowly so by recurving of the margins, 3–6 mm long, 1.8–2.3 mm wide, acute or obtuse, with strongly recurved or revolute margins, the apex a very reduced point; abaxial surface pale green, with 2 or sometimes 3 main rows of usually c. 6 oil glands; adaxial surface olive-green, with oil glands inconspicuous. *Inflorescence* occupying 1–5 nodes per branchlet (the fertile nodes not always consecutive), with up to 3 but often only 1 or 2 flowers per node. *Peduncles* spreading, straight or somewhat recurved, 2–3.5 mm long, almost terete. *Bracteoles* caducous or deciduous, incurved to a very narrow shape, linear in outline, 0.5–0.7 mm long, acuminate, reddish. *Pedicels* 0.7–1.2 mm long. *Flowers* 5–6 mm diam. *Hypanthium* with adnate part obconic and free part horizontal, c. 0.6 mm long, 1.8–2.2 mm diam., often reddish. *Sepals* depressed ovate, c. 0.7 mm long, c. 1.3 mm wide, broadly obtuse, the herbaceous part dark red and somewhat thickened; thin-textured margin narrow, whitish. *Petals* widely spreading, concave on upper surface, 2–2.5 mm long, white, deciduous in fruit. *Staminodes* (2–)5, antipetalous, c. 0.15 mm long. *Stamens* 17–23, with 2–5 opposite each sepal, the longest ones tending to be opposite the sepals but alternating with shorter stamens, the shortest filaments united for all or nearly all their length. *Longest filaments* 1.5–2 mm long, united for about half their length, the free part filiform. *Anthers* very varied in size in each flower, the smallest ones infertile (on the staminodes) and c. 0.15 mm long, the largest c. 0.4 mm long and all intermediate sizes also present. *Ovary* about half-inferior, summit prominently 3-lobed; ovules erect, 1 per loculus. *Style* slender, 1.4–1.7 mm long; stigma peltate or almost peltate, 0.15–0.2 mm diam. *Fruits* c. two-thirds-superior, c. 1.8 mm long, c. 2.3 mm wide. *Seeds* usually formed from the single ovule in each loculus (i.e. no chaff present), erect, 1.1–1.3 mm long, c. 0.4 mm wide, 0.5–0.6 mm deep including inner protrusion, off-white; inner protrusion extending down from top of seed for less than half the length of the seed body, 0.3–0.5 mm long, 0.25–0.3 mm deep. (Figures 2B, 3)

*Selected specimens examined.* WESTERN AUSTRALIA [all from type locality]: 1 May 1997, E.D. Middleton EDM 33 (PERTH); 29 Mar. 2005, E.D. Middleton EDM 702 (AD, BRI, NSW, PERTH); 12 May 2005, B.L. Rye 250505, 250506 & E.D. Middleton (PERTH).

*Distribution and habitat.* Known from a single locality between Lake Muir and Walpole (Figure 5D), recorded close to a peat swamp, growing with a variety of myrtaceous species including *Beaufortia sparsa*, *Taxandria parviceps*, *Homalospermum firmum* and *Astartea arbuscula* and with a wide variety

of other taxa such as *Adenanthes obovatus*, *Acidonia microcarpa* and *Anarthria scabra*.

*Phenology.* Flowers recorded March to May and fruits in May.

*Insect associations.* Black scales seen on the undersurface of the leaves are very compressed, with a slight ridge along the centre of the exposed dorsal surface, and have a continuous white border (Figure 2B).

*Conservation status.* Listed by Smith (2012) as Priority Two (DEC Conservation Codes for Western Australian Flora) under the name *H. sp.* Walpole (E.D. Middleton EDM 33). This species, known from a single locality, was common on the road verge, apparently favoured by disturbance, but few plants were visible in the thick, adjacent vegetation of sedges and low shrubs.

*Etymology.* As for the section, the epithet refers to the whorled leaves in this species.

*Affinities.* Differs from the other member of sect. *Verticilla*, *H. connatum*, in its smaller, broader leaves with a very reduced apical point, smaller flowers, more variable stamens, lower ovule number and peltate stigma. It also seems to have more spreading leaves.

The first specimen of *H. verticillare*, collected in 1997, was housed for several years in *H. minus* (as *H. cordifolium* subsp. *minus*). The new species occurs within the range of *H. minus* in a similar damp habitat, and has leaves of a similar shape and colour. The two species show all the differences that separate the sections *Cardiomyrthus* and *Verticilla*, with particularly striking differences in their androecium. *Hypocalymma verticillare* is unique in the genus in having very large differences in the sizes of its anthers and in having a number of solitary, very short, antipetalous staminodes, in addition to the small, moderate-sized and large stamens occurring in groups of two to five opposite the sepals. Directly opposite each sepal there is usually either a moderate-sized stamen (with a large stamen on each side of it), or a single long stamen (bordered by shorter stamens), but there are never more than two large stamens per sepal. While the thecae of the large and small anthers differ markedly in size, the connective gland does not differ much; it is about as large as each of the thecae on the staminodes but greatly exceeded in length by the thecae of the largest anthers.

*Notes.* The free part of the hypanthium is more or less horizontal so does not increase the length of the hypanthium to any significant degree but contributes greatly to its width. Each loculus of the ovary contains an almost sessile placenta, which is broadly attached at the centre. In *H. verticillare* the stigma barely protrudes from the ovary summit at the stage of pollen release from the anthers although it is well exserted by the fruiting stage (Figure 3C). Figure 3B shows the stigma at an intermediate stage.

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